TEAM LEARNING AND REFLEXIVITY IN TECHNOLOGY-MEDIATED DISTRIBUTED TEAMS

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ABSTRACT

This study examines technological, learning, and social affordances associated with the facilitation of team learning during technology-mediated collaborative problem solving. A direct observation approach is used to rate observable behaviors associated with team learning and team reflexivity. Results showed that collocated teams did engage in better quality team learning behaviors than non-collocated technology-mediated teams. Further, periodic reflection on task progress, solution accuracy, and team interactions yielded better team productivity and higher quality interpersonal interactions.

INTRODUCTION

Team learning and knowledge management has been viewed as a form of intellectual capital that can be leveraged to create organizational value and a competitive advantage [12]. Consequently, it essential to develop a deeper understanding of the processes teams undergo to learn, create and share knowledge. This study views team learning as both a cognitive process (i.e. information exchange, idea interpretation, experimentation, and reflection; see [7]) and a situated learning process (i.e. co-construction of knowledge via collaboration structured by its social and physical environment; see [11]).

LITERATURE REVIEW

Team Learning Processes

Slavin [13] and later Edmondson [7] conceptualized learning as an iterative cycle of information exchange, idea interpretation and reflection. In other words, team learning involves the exchange of facts and concepts, experimenting with ideas, joint reflection on them, and the collective restructuring and fine tuning of them. During information exchange, participants offer comments and ideas that lead to the accumulation of and experimentation with interpretations that constitute a mental model (i.e. an ordered set of causal propositions and facts that describes phenomena; see [5]). Joint reflection checks and confirms shared understanding. Restructuring involves comparison of different perspectives to assess the need for potential new relations among facts and concepts. Fine tuning involves resolution of conflicting viewpoints to define boundaries of the mental model and helps to make the task's scope more explicit.

Task and Social Reflexivity

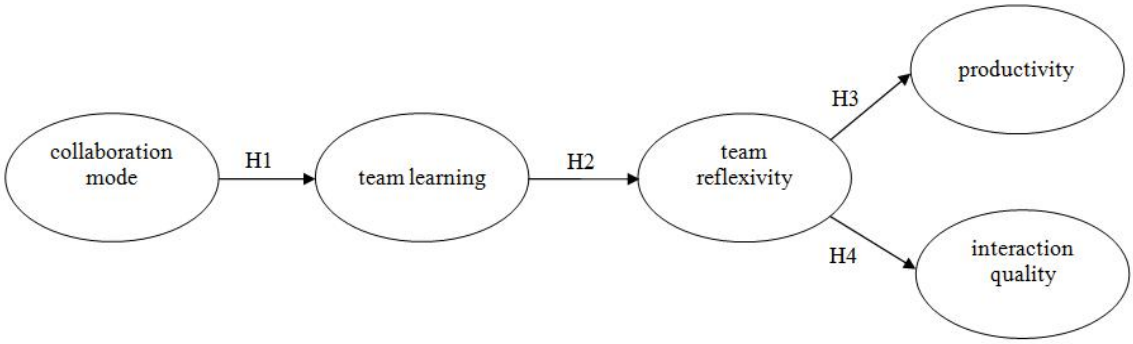
Team reflexivity is the process of monitoring both the task and social context of team-based collaborative work [6]. There are three central elements to the concept of reflexivity—reflection, planning, and adaptation. Reflection consists of behaviors such as critical analysis of alternative solutions and monitoring of task progress and status so that upcoming actions can be determined.

Reflective behaviors give rise to planning as a shared understanding of the task is developed and desired future task states are determined. Reflection and planning identifies relevant opportunities for adaptations which are goal-directed behaviors aimed at leading to the desired task state. Social reflexivity refers to the extent to which teams monitor social interactions to assure negotiated conflict handling, provide mutual support among team members, and promote a climate where risk-taking is encouraged and mistakes are not penalized [6].

RESEARCH MODEL AND HYPOTHESES

The research model is depicted in Figure 1 below. The model draws on theory of affordances [9] and social impact [10] theoretical frameworks to explain the effects of collaboration mode on team learning behaviors and their subsequent impact on team performance and interaction quality. Task and social reflexivity (i.e. team reflexivity) are suggested to be forms of meta-cognition that is the mediating mechanism that translates learning outcomes into productive and quality interactions.

Figure 1. Research Model



Collaboration Mode and Team Learning

Kirschner et al. [9], suggested that in order to achieve successful collaborative learning outcomes, a learning environment must provide 1) tools and procedures (*technological affordance*), 2) the opportunity to stimulate, facilitate, and maintain information exchange and idea evaluation (*educational affordance*), and 3) a cooperative, supportive, and trusting climate (*social affordance*). Social impact theory (SIT) suggests that behavior is guided by social influence derived from 1) salience or importance attributed to team members (*strength*), 2) time, spatial, or interpersonal distance among team members (*immediacy*), and 3) the quantity of influential sources (*numbers*). Recent research has also shown that relative to collocated teams, non-collocated technology-mediated teams inherently exhibit lower strength and immediacy effects and therefore encounter more negative team process behaviors such as withdrawal from participation and diminished communication/information exchange [2]. In addition, it is argued that technology-mediated settings are relatively lower in the affordances of team learning attributed to communication deficiencies that require greater coordination efforts. Thus, the following hypothesis is proposed.

HYPOTHESIS 1. *Groups working in a face-to-face collaboration setting should exhibit more effective team learning behaviors than in a technology-mediated setting.*

Team Learning and Reflexivity

Inadequate knowledge acquisition attributed to poor team learning can result in misunderstandings and/or the presence of divergent perspectives that limit a team's ability engage in task and social reflection effectively. In addition, inadequate knowledge can impede the activation of new related knowledge and the real-time refinement of goals and adaptation of task procedures. A reflexive team must be able to assess the current state of a task's solution and execution plan alignment with task requirements. This study also argues that accurate assessment of the social context developed during the team learning process makes a team better equipped to create a supportive task context [8], constructively and objectively deal with conflict [6] and address any motivational or interpersonal problems that may arise [14]. Consequently, the following hypothesis is proposed.

HYPOTHESIS 2. *Increased team learning will facilitate more effective team reflexivity.*

Team Reflexivity and Task Outcomes

Teams that are unable to adequately reflect on task status and alignment with task objective are likely to experience process losses, frustration, conflict, and distrust [8]. Team reflexivity can stimulate a process of shifting from bad to good ideas and problem solutions, and ultimately improved team performance [6] and can promote development of cooperative goals and minimize disconfirmation of expectations that result in a supportive and cooperative task environment [14]. Thus, the following hypotheses are proposed:

HYPOTHESIS 3. *Improved team reflexivity will be positively associated with team productivity.*

HYPOTHESIS 4. *Improved team reflexivity will be positively associated with team interaction quality.*

RESEARCH METHODOLOGY

To test the research model and hypotheses, a laboratory experiment was conducted to examine the effects of two different modes of team collaboration – face-to-face and non-collocated technology-mediated collaboration. Forty-eight participants were drawn from a population of Management Information Systems undergraduate students familiar with the Systems Development Life Cycle approach to software design and knowledge of structured programming. The teams, comprised of four members, were required to enhance the functionality of a hypothetical university information system. The experimental task required each team to construct software design documentation that included (1) a hierarchy chart, (2) a list of function prototypes, and (3) pseudocode for each function identified as part of a solution to the problem.

Measures

The behavioral observation approach was used in assessing team learning, team reflexivity, and shared mental model by using three trained observer ratings of associated task-related and affect-related behaviors. In providing their ratings, three trained observers used a rating scale that ranged from 1 (very low) to 7 (very high). The interrater agreement index for all scale ratings ranged from $a_{wg(j)} = 0.85$ to $a_{wg(j)} = 0.98$ indicating very good interrater agreement [3]. Scale items appear in Table 1 below. The team productivity measure was determined by awarding one point for each correct specification of any data value of a specific data file, correct output and input data value of a program module (i.e., function or subroutine), and correct specification of program statement needed in a specific program module.

Measurement Model

To assess internal consistency reliability, convergent validity and discriminant validity of the construct measurements, the constructs' composite reliabilities (CR) and the average variance extracted (AVE) were calculated using partial least squares (PLS). Composite reliability scores for every construct (ranging from 0.874 to 0.975, as shown in Table 1) are well above 0.70, which is the suggested benchmark for acceptable reliability [4]. In addition, the t-statistics for the item to construct loadings were all significant at $p \leq .01$. These results indicate that the measurement model has displayed both item internal consistency reliability and item convergent validity.

Table 1. Composite Reliability, AVE, and Indicator Loadings

Construct and Item Level Values		**loading**
Team Learning (Composite Reliability = 0.975; AVE = 0.885)		
TeamLearn1	Some team members were just listening without providing any verbal input	0.925
TeamLearn2	Ideas were easily developed and improved through team-wide discussion	0.917
TeamLearn3	All team members provided useful verbal input	0.976
TeamLearn4	Ideas were thoroughly discussed and evaluated among all team members	0.922
TeamLearn5	Team-wide consensus was confirmed before moving forward with an idea	0.963
Team Reflexivity (Composite Reliability = 0.894; AVE = 0.740)		
Reflexivity1	Frequent double-checking the work done by others is done right	0.946
Reflexivity2	Frequent double checking that the solution is meeting requirements	0.914
Reflexivity3	Team made obvious effort to create and maintain a positive climate	0.700
Interaction Quality (Composite Reliability = 0.869; AVE = 0.696)		
IntQual1	Felt frustrated or tense about another team member's behavior	0.620
IntQual2	Expressed negative opinion about another's team member's behavior	0.915
IntQual3	Observed others express a negative opinion about your behavior	0.930

Discriminant validity is evidenced when all the loadings of the scale items on their assigned latent variables or construct are larger than their loading on any other latent variable. Table 2 below provides the correlations of each item to its intended latent variable (i.e., loadings) and to all other constructs (i.e., cross loadings).

Table 2. Indicator Loadings

	Latent Variable Item Loadings		
Item	**Team Learning**	**Team Reflexivity**	**Interaction Quality**
TeamLearn1	**.925**	.580	.637
TeamLearn2	**.917**	.700	.644
TeamLearn3	**.976**	.698	.724
TeamLearn4	**.963**	.659	.663
TeamLearn5	**.922**	.662	.706
Reflexivity1	.626	**.946**	.698
Reflexivity2	.616	**.913**	.592

Reflexivity3	.577	**.701**	.609
InteractionQual1	.612	.707	**.915**
InteractionQual2	.373	.335	**.620**
InteractionQual3	.744	.705	**.930**

Table 3 below indicates that the AVE square roots that appear in the diagonal are larger than any correlation between the associated construct and any other construct [4]. This AVE analysis result and the item to construct loadings discussed above suggest that the measurement model displays discriminant validity.

Table 3. Latent Variable correlations and square root of AVE

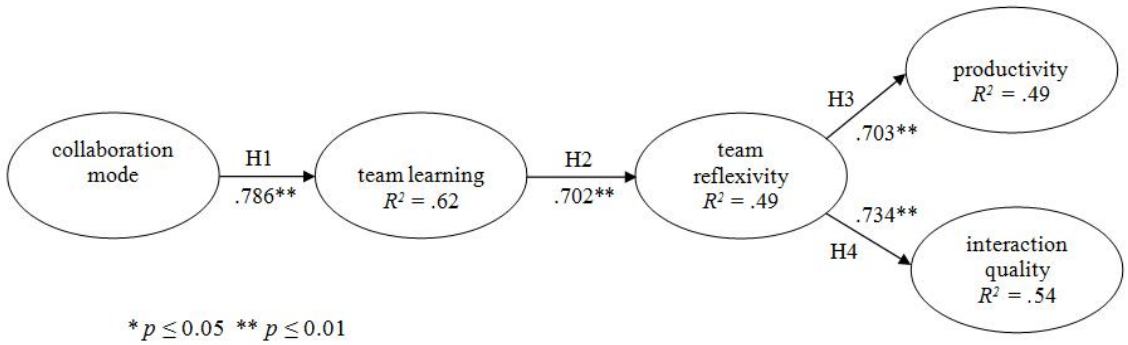
	Team Learning	Team Reflexivity	Interaction Quality
Team Learning	**.941**		
Team Reflexivity	.702	**.860**	
Interaction Quality	.717	.734	**.834**

Note: square root of the constructs' AVE appear in the diagonal

Structural Model

Using PLS Graph (Version 3.0 Build 1130), the structural model and hypotheses were assessed by examining path coefficients and their significance levels [4].

Figure 2. PLS Analysis Results



The PLS analysis results (Figure 2) show that all the hypotheses are supported. Collaboration mode was shown to increase team learning (b = 0.786, t = 8.410, $p \leq .01$) thereby supporting hypothesis 1. Hypothesis 2 was supported in that team learning increased team reflexivity (b = 0.702, t = 7.954, $p \leq .01$). Team reflexivity lead to increases in both productivity (b = 0.703, t = 8.495, $p \leq .01$) and interaction quality (b = 0.734, t = 3.820, $p \leq .01$) indicating support for hypothesis 3 and hypothesis 4 respectively. All of the mediation paths in the model were shown to conform to the requirements indicating that 1) team reflexivity mediated team learning on productivity and interaction quality and 2) team learning mediated the impact of collaboration mode on team reflexivity [1].

CONCLUSION

The study's findings indicated that technology-mediated settings are lower in technological, educational, and social affordance as compared to collocated settings where *strength, numbers*, and *immediacy* effects are higher. In some cases, diminished team learning observed in non-collocated technology-mediated settings was attributed to collaborative effort overhead aimed at overcoming reduced participation levels, incoherent communication exchanges, lower quality interactions and episodes of confusion regarding task requirements and potential solutions. Consequently, management of technology-mediated collaboration must look beyond mere technical facilitation of information exchange and begin to consider specific processes such as team learning and reflexivity that are more directly related to task outcomes. Finally, the direct observation approach is essential to capture the dynamic and emergent processes that teams undergo during collaborative problem solving.

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