Learning to Work in Partially Distributed Teams: The Impact of Team Interaction on Learning Outcomes

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Abstract

Partially distributed teams (PDTs) consist of two or more subteams that are separated geographically. This paper presents the results of a study of global partially distributed student teams collaborating over a five-week period. Over one thousand students participated from more than a dozen universities spanning nine countries. By understanding what drives learning, we are better equipped to prepare students for careers in the global marketplace. Thus, the research question addressed is, “What are the relative impacts of team interaction variables on (1) learning to work in partially distributed teams and (2) learning skills pertaining to requirements determination and high-level design within the domain of emergency management information systems (EMIS)?” Eight explanatory variables were investigated in a multiple regression analysis. Three variables, coordination, interaction performance, and (lack of) conflict were significant in both within and between subteam analyses in both learning contexts. Shared identity was significant regarding PDT learning while personal and process trust were significant regarding EMIS domain learning.

1. Introduction

Partially distributed teams (PDTs) consist of two or more subteams that are separated geographically. In a PDT, the members of any given subteam are co-located, (thus they may meet face-to-face), but they collaborate remotely with members of other subteams using information and communication technology. Virtual teams, and especially PDTs, are an increasingly normal mode of operation in a variety of domains including IT, engineering, disaster management and business [1]. Often the geographic distance separating subteams spans multiple time zones and countries, as in the case of global software development PDTs; the time zone differences and cultural differences pose significant challenges to the groups [9; 19; 32; 53]. Thus, an essential professional skill is knowing how to communicate and work effectively in such teams. As Davis et al. [14, p. 351] state, “As global, virtual teams become more prevalent in the workplace, it is imperative that we, as educators, prepare IS students for this trend.”

Over the last several years, we have conducted five semesters of field studies involving student PDTs. Our over-arching goal in this research stream is to provide students with deep learning experiences related to working in PDTs. This paper presents the results of a study of PDTs involving over one thousand students from over a dozen universities in nine countries. 123 teams participated in the study. All teams consisted of two subteams. Most of the teams were global (88%), meaning that each subteam was located at a university in a different country. In nearly all cases, one subteam was located in the U.S. The research question addressed in this paper is: “What are the relative impacts of team interaction variables on (1) learning to work in partially distributed teams and (2) learning skills pertaining to requirements determination and high-level design within the domain of emergency management information systems (EMIS)?” By understanding what drives learning, we are better equipped to prepare students for careers in the global marketplace.

2. Literature Review

The Unique Problems of Partially Distributed Teams

Distributed teams and their variant, globally distributed teams, are an increasingly common means of accomplishing work in today’s corporate arena, as work environments have come to depend more and more on international interactions and exchanges [11; 12; 16; 20; 38]. Organizations employ globally distributed teams for a variety of purposes, such as tapping into far-flung talent, establishing a presence in different geographic regions, customizing products for different countries, and reducing costs. PDTs are a typical configuration for globally distributed
information technology (IT) project teams in general, and software development teams, in particular [32, 53].

Given the prevalence of PDTs, there is a pressing need to understand and address the unique demands of this particular configuration [11]. For example, recent research indicates that PDTs are prone to in-group team dynamics, denoted by increased interaction with and preferential behavior towards members in one’s sites; reduced trust and team cohesiveness as well as increased conflict between distributed sites [46; 50; 49]. Members of PDT subteams conduct much of their teamwork via face-to-face interaction. The shared physical context coupled with the rich social cues present in face-to-face collaboration fosters cohesion, the development of a shared identity, and better conflict management within subteams [32; 24]. However, in-group team dynamics between subteams threaten overall team cohesiveness and development and can have dire consequences on team performance [3; 24; 42]. Thus, the training modules we developed for students were explicitly directed at increasing team cohesion, and decreasing in-group team dynamics.

Using Constructivist Learning to Educate Students about PDTs

Employers seek IT graduates who are “job ready.” The 2008 Information Technology Curriculum Guidelines call on IT educators to “ease the transition from academia to the business world by teaching students to work in teams and providing significant project experiences” [35, p. 45]. The guidelines also state that “IT educational programs need to provide students with experiences where they can apply international, intercultural, and workplace issues within the context of computing resources, teamwork, and projects” [ibid].

Recent decades have seen a move away from “objectivist” pedagogy and towards constructivist approaches which provide more engaging and group-oriented or collaborative approaches to university courses [23]. Constructivist learning treats the student as an active participant in individual or group learning activities. Learning is conceived of as something a learner does, not something “done to” the learner [29]. The instructor becomes primarily a facilitator, aiding the students via the creation of authentic (realistic) tasks and providing feedback. Thus, rather than lecturing about how to work in virtual teams, the constructivist approach supports students in learning about this through first-hand experience.

Our constructivist approach in the PDT project incorporates elements of Project-Based Learning, Team-Based Learning, and collaborative approaches to online learning; it thus extends the transformative changes in higher education that have become increasingly widespread in recent years. Project Based Learning (PBL) is “a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks” [7]. It emphasizes authentic “real world” tasks that incorporate the project management skills so valued by today’s global industries [8]. Team-Based Learning (TBL) emphasizes team development and has been shown to enhance motivation, long-term retention, critical thinking, and communication skills [39]. By keeping groups intact through a series of well-planned activities designed around a three-phase sequence of preparation, application, and assessment, TBL has been shown to enhance learning achievement in traditional face-to-face (FiF) classroom settings [40]; FiF classes supported by a mix of synchronous and asynchronous communication media [17]; and strictly online learning contexts [5, 6]. Learning online through collaborative group activities in Asynchronous Learning Networks or “virtual classrooms” was shown in the latter three studies to be effective, especially as compared to having students work individually in online environments.

With the goal of preparing students to work in a global team context, IT educators across the computing disciplines are striving to incorporate distributed development projects into their courses [1]. Notable multi-year international efforts in addition to our own include the Global Studio Project [52], the Runestone Project [33], the Australian-Sweden collaboration [10] and HKNET [54]. The closest study to the one reported here is by Davis et al. [14].

3. Pedagogical and Research Procedures

There are two learning goals for students in the PDT project: (1) to learn how to work effectively in the PDTs that are prevalent in much software development today, which we refer to as PDT learning and (2) to learn about software development requirements in the application domain area of emergency preparedness and management, which we refer to as EMIS domain learning. These two goals were addressed throughout the five-week PDT project via weekly activities and deliverables.

Regarding PDT learning, we developed three empirically based learning modules using collaboration records and evaluation data we obtained during prior field studies. Each module followed the Team Based Learning sequence of preparation, application, and assessment. Each module is designed to address a specific goal in terms of addressing challenges faced by PDTs, and contains subteam and
team activities associated with a specific team deliverable. Briefly, Module 1 was designed to get teams off to a good start during the first week of the project. Module 2 was designed to help move teams from “us vs. them” (separate subteam identities) to “we” (whole-team identity). Module 3 was designed to establish a positive team trajectory. Subteams and teams completed weekly activities in each PDT training module as well as accompanying deliverables (for a detailed description of module contents, see Ocker et al., 2009).

Regarding EMIS domain learning, students worked on the GRRR (Grassroots Regional Resource Repository) task (see description below) during weeks two through five. Subteams and teams completed a three-part stakeholder analysis and user interface design in weeks two through four, with weekly activities and deliverables. In week five, teams completed the final team proposal, which consisted of a revision of previous GRRR deliverables plus the completion of several additional report sections.

GRRR Task: The project was designed to be appropriate for students from different geographic regions and cultures, and for students with varying levels of systems analysis skills. We focused on the front-end of the software development process because of the heavy emphasis on communication and on developing a shared understanding of the problem domain, key challenge areas in distributed work (for reviews see 21, 36, 47, 51). Specifically, students worked on the GRRR task, where teams had to analyze and report on the high-level functionality and user-interface design for a self-help regional emergency preparedness and management information system. The purpose of the system is to provide a way for those living in a given geographic region (e.g., Costa Rica) to locate and manage the resources of that region (e.g., skilled labor, equipment, supplies) so that the resources can be deployed efficiently and effectively in a disaster.

Participants: More than 1200 students, organized into 123 teams, participated in the PDT project during Fall 2009 and Fall 2010. Students came from over a dozen universities located across nine countries (Australia, Germany, Ireland, Lithuania, Mexico, Singapore, Spain, Switzerland, and the United States, including universities in Alabama, Georgia, Missouri, Pennsylvania, Washington, and Wisconsin). Partially distributed teams were formed such that each team consisted of two subteams; each subteam was from a different university. Team composition by country (i.e., subteam pairings) is shown in Table 1. Most subteams consisted of four-five students drawn from the same collocated class; thus, members within a given subteam were able to meet face-to-face. However, subteams within a given team were geographically distant from one another.

### Table 1. Team Composition by Country

<table>
<thead>
<tr>
<th># of Teams</th>
<th>Team Composition</th>
<th># of Teams</th>
<th>Team Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>Lithuania-USA</td>
<td>7</td>
<td>Ireland-USA</td>
</tr>
<tr>
<td>23</td>
<td>Spain-USA</td>
<td>6</td>
<td>Zurich-USA</td>
</tr>
<tr>
<td>15</td>
<td>USA-USA</td>
<td>4</td>
<td>Lithuania-Spain</td>
</tr>
<tr>
<td>12</td>
<td>Mexico-USA</td>
<td>3</td>
<td>Germany-USA</td>
</tr>
<tr>
<td>10</td>
<td>Singapore-US</td>
<td>3</td>
<td>Australia-US</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Australia-Spain</td>
</tr>
</tbody>
</table>

Participating universities were recruited through an announcement on AISWorld and through personal contacts. Participants were required to have a working knowledge of English; all deliverables were written in English. Instructors were required to weight the PDT project a minimum of 15% of the course grade.

Communication Platform: Each team was provided with private space on Moodle, a free and open source course management system. The system, referred to as the PDT System, provided a file sharing repository, threaded discussion board, and a project calendar. The system was configured to support activity at both team and subteam levels; each student was given an account and password and only his or her team was visible upon logging into the system. A project requirement was that all “deliverables” (including the final project report) be posted online, using the PDT system. The participants were free to use other technologies in addition, such as instant messaging, email, or phone.

### Measures of Dependent Variables

**Student Learning:** We report on two aspects of perceived student learning: (1) PDT learning and (2) EMIS domain learning. To measure these aspects, we adapted questionnaire items from [22] and [2]. At the conclusion of the PDT project, a post survey containing the learning measures, as well as measures for team interaction constructs, was administered to participants. Seven-point Likert-type scales were used to measure all learning and team interaction items. The items for each scale are shown in the appendix.

### Measures of Explanatory Variables

**Team Interaction:** To determine the impact of team interaction variables on learning outcomes, we investigate the effects of six variables which prior
research indicates are important to PDT interaction [42, 43]. The degree of shared identity and trust are socio-emotional constructs, emphasizing how members feel about their teams. Shared identity with the team is important in enhancing cohesion and reducing conflict, and is especially critical in a virtual context (e.g., [24]). Trusting relationships in a team promote cooperation and respect, resulting in better outcomes [25]. However, establishing trust is particularly difficult across distances [26]. Prior research indicates that trust consists of personal trust (based on member interactions) and process trust (based on team processes) [49]. A second pair of variables, awareness and coordination, relate to procedural aspects of team management. Awareness concerns an understanding of others’ activities, and thus provides a context for interpreting behavior [15]. Coordination refers to the additional work that is required when multiple individuals work together on a task. Coordinating member efforts across distance, especially when multiple time zones and/or cultures are in play is challenging [31, 51, 55].

A third pair of variables, member competence and conflict, pertain to behavioral aspects of team interaction and captures how members perceive their team members interacting. Competence pertain to beliefs about the ability of team members to successfully complete the work of the team. It combines aspects of group potency and collective efficacy [18, 34]. Conflict can be defined as disagreements among team members due to perceived incompatibilities or differing viewpoints or goals [28, 50]. Conflict may be more prevalent in virtual contexts [14, 24]. The lack of immediate feedback [30] as well as time zone and cultural differences may exacerbate conflict [37].

Competence was measured using a scale with three items adapted from Jarvenpaa et al. [26]. Conflict and shared identity were each measured using a three-item scale; both measures were adapted from Mortensen and Hinds (2001). Based on our previous research [49], trust was measured using ten items (four adapted from Jarvenpaa et al. [27] and six questions from Cummings and Bromily [13] to form two trust scales: personal trust and process trust. As a result measure of team interaction, we include a seventh scale, team interaction performance, adapted from Mortensen and Hinds [41]. It consists of six items to measure aspects of interaction efficiency, quality, creativity, adherence to schedule, coordination, and communication. The competence, conflict, and trust scales gathered perceptions about distributed subteams; shared identity and team interaction performance were judged with respect to the team as a whole. All items were measured using a 7-point semantic differential response scale.

### 4. Analysis and Results for Student Learning

Data collected from the post-project survey, administered at the end of the project, is used in this analysis. 779 usable post survey responses were received and are included in the analysis of results for all explanatory variable scales except process trust. In this case, survey items were modified in Fall 2010. Therefore, only surveys from 2009 are included in the analysis of process trust.

A principal components analysis with Varimax rotation of the scale items was conducted for all scales. The anticipated factor loadings (not shown here) were obtained, indicating that all scales are a single factor, except for Trust, which has two factors, Personal Trust and Process Trust, as expected.

#### Table 2. Descriptive Statistics for Learning and Team Interaction Scales

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. D.</th>
<th>Mean</th>
<th>Std. D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Dist. Team</td>
<td>779</td>
<td>5.37</td>
<td>1.50</td>
<td></td>
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</tr>
<tr>
<td>Learning EMIS</td>
<td>779</td>
<td>4.50</td>
<td>1.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Between/ Within</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coordination</td>
<td>779</td>
<td>4.77</td>
<td>1.53</td>
<td>5.26</td>
<td>1.25</td>
</tr>
<tr>
<td>Performance</td>
<td>779</td>
<td>5.31</td>
<td>1.34</td>
<td>5.65</td>
<td>1.19</td>
</tr>
<tr>
<td>Conflict (rev.)</td>
<td>778</td>
<td>5.74</td>
<td>1.10</td>
<td>6.10</td>
<td>0.97</td>
</tr>
<tr>
<td>Awareness</td>
<td>778</td>
<td>4.63</td>
<td>1.74</td>
<td>5.71</td>
<td>1.36</td>
</tr>
<tr>
<td>Capability</td>
<td>778</td>
<td>5.22</td>
<td>1.67</td>
<td>5.80</td>
<td>1.37</td>
</tr>
<tr>
<td>TrustPerson (rev)</td>
<td>778</td>
<td>5.31</td>
<td>1.51</td>
<td>5.75</td>
<td>1.26</td>
</tr>
<tr>
<td>TrustProcess (rev)</td>
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<td>5.27</td>
<td>1.35</td>
<td>5.52</td>
<td>1.35</td>
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<td>SharedID</td>
<td>778</td>
<td>5.41</td>
<td>1.60</td>
<td>6.06</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Learning Outcomes: The learning scales are moderately correlated with one another; Pearson’s R is .69. Thus, besides the adequate internal consistency supported by the principal components analysis, the learning scales have adequate discriminant validity. Descriptive statistics for learning scales are displayed at the top of Table 2. Both learning outcomes were rated above the scale midpoint of 4.0. Specifically, students rated PDT learning at 5.37, nearly 1½ points above the scale midpoint. EMIS domain learning was rated ½ point above the midpoint, at 4.50.

Team Interaction: Scale items were reversed for conflict and process trust to aid comparison, so that a higher mean score indicates a better rating for all explanatory variables. Regarding team interaction
variables, as shown in Table 2, all ratings are above the scale midpoint, with the highest scores obtained for (lack of) conflict within subteams (6.1) and shared identity within subteams (6.06). In all cases, members rated within subteam interaction higher than between subteam/team interaction, with the largest differences found for awareness (over 1 pt.), followed by shared identity (.65), capability (.57), coordination (.49), personal trust (.44), conflict (.36), performance (.34), and process trust (.26).

Results of Regression Analysis

Multiple regression analyses were used to determine the association between learning outcomes and explanatory variables. Data assumptions of the regression model were tested as follows. The linearity of each explanatory variable was visually assessed using a scatter plot and determined to be acceptable. Independence of learning outcomes was assessed via a correlation analysis ($r=.69$). Multicollinearity was assessed by calculating the variance inflation factor (VIF), which is a statistic used to measure possible multicollinearity among the explanatory variables. All VIFs were well below the recommended cutoff value of 10 [4]. Q-q plots were used to assess normality of dependent variable distributions; the plots indicate that the distributions were fairly normal.

The results of the regression analyses are shown in Tables 3-6. Regarding PDT learning (Table 3), between subteam explanatory variables accounted for 45% of the variance. A significant association was found for (in order of strength of effect) team interaction performance, coordination, (lack of) conflict, capability of distant subteam members, and shared team identity. Within subteams explanatory variables accounted for a smaller but still substantial 27% of the variance in PDT learning. A significant association was found for coordination, shared team identity, (lack of) conflict, team interaction performance and awareness. In terms of EMIS domain learning, between subteams explanatory variables (Table 4) accounted for 32% of the variance. A significant association was found for team interaction performance, coordination, awareness, (lack of) conflict, and personal trust. Within subteams explanatory variables accounted for 31% of the variance in EMIS domain learning. A significant association was found for coordination, team interaction performance, process trust, awareness, (lack of) conflict, and personal trust.

**Table 3. Regression Results for PDT Learning -- Between Subteam Analysis**

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>Std. Coeff.</th>
<th>t</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>Coordination</td>
<td>0.27</td>
<td>0.05</td>
<td>0.27</td>
</tr>
<tr>
<td>Performance</td>
<td>0.32</td>
<td>0.06</td>
<td>0.29</td>
</tr>
<tr>
<td>Conflict (rev.)</td>
<td>0.23</td>
<td>0.06</td>
<td>0.16</td>
</tr>
<tr>
<td>Awareness</td>
<td>0.01</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>Capability</td>
<td>0.13</td>
<td>0.06</td>
<td>0.15</td>
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<tr>
<td>Process Trust</td>
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</tr>
<tr>
<td>SharedID</td>
<td>0.10</td>
<td>0.05</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Adj. R Sq. = .45 (p=.000)
*p<.05  **p<.01  ***p<.001

**Table 4. Regression Results for PDT Learning -- Within Subteam Analysis**

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>Std. Coeff.</th>
<th>t</th>
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<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>Coordination</td>
<td>0.32</td>
<td>0.06</td>
<td>0.26</td>
</tr>
<tr>
<td>Performance</td>
<td>0.20</td>
<td>0.08</td>
<td>0.16</td>
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<tr>
<td>Conflict (rev.)</td>
<td>0.26</td>
<td>0.08</td>
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<tr>
<td>Awareness</td>
<td>0.12</td>
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<tr>
<td>Capability</td>
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<td>Personal Trust</td>
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<td>0.24</td>
<td>0.07</td>
<td>0.20</td>
</tr>
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</table>

Adj. R Sq. = .27 (p=.000)
*p<.05  **p<.01  ***p<.001
5. Discussion and Conclusions

To recap, in this study we looked at two types of student learning across two learning contexts. In terms of learning types, we investigated learning to work in partially distributed teams and learning skills pertaining to requirements determination and high-level design within the domain of emergency management information systems. In terms of learning context, the analysis looked at the interaction between distant subteams as well as interaction occurring within subteams.

Regarding learning to work in partially distributed teams, not surprisingly, between subteam interaction accounted for nearly twice as much variance (45%) compared to within subteam interaction (27%). However, with respect to learning EMIS domain skills, both between and within subteam interaction accounted for roughly the same (one-third) amount of variance. Of the eight explanatory variables, a set of three -- coordination, interaction performance, and (lack of) conflict -- was significant across all four (two between and two within) learning outcomes. We interpret this to indicate that these variables constitute a base level of team functioning that transcends learning situations. Without achieving satisfactory levels of basic team interaction processes such as effective coordination and communication, while maintaining a reduced level of conflict, subteams and teams cannot perform at a high enough level to learn. Thus, continued efforts must be focused on training students in terms of these basic teaming skills. Note that learning these skills in a distributed context also translates into skills applicable to face-to-face teams.

Of these three key factors, coordination procedures are perhaps most amenable to structuring and provision of guidelines by instructors. Note that this project was quite structured in terms of weekly activities and deliverables, rather than just giving a single project deliverable at the end. Perhaps a series of suggestions for ways of coordinating work in PDTs should be provided as part of the training, and the choice of these procedures built into the agreement on procedures that our teams were required to state in week one. Likewise, if a mid-project assessment shows high levels of conflict, perhaps a tutorial could be developed on how to work through this conflict in a productive manner. The performance measures, which were collected only after the project, are not amenable to intervention.

Interestingly, only between subteam perceptions of member capability were significant for between subteam PDT learning while awareness had the opposite outcome, being significant in all other learning contexts. We speculate that these results may be tied to leadership structure that results in a

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Table 5. Regression Results for EMIS Domain Learning -- Between Subteam Analysis

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>Std. Coeff.</th>
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<tr>
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<tr>
<td>Coordination</td>
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<tr>
<td>Performance</td>
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<td>Process Trust</td>
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<tr>
<td>SharedID</td>
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<td>0.05</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Adj. R Sq. = .32 (p=.000)
*p<.05  **p<.01  ***p<.001

Table 6. Regression Results for EMIS Domain Learning -- Within Subteam Analysis

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>Std. Coeff.</th>
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<tr>
<td></td>
<td>B</td>
<td>Std. Err.</td>
<td>Beta</td>
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<tr>
<td>Coordination</td>
<td>0.34</td>
<td>0.06</td>
<td>0.29</td>
</tr>
<tr>
<td>Performance</td>
<td>0.36</td>
<td>0.07</td>
<td>0.30</td>
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<tr>
<td>Conflict</td>
<td>0.17</td>
<td>0.07</td>
<td>0.12</td>
</tr>
<tr>
<td>Awareness</td>
<td>0.12</td>
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<td>Capability</td>
<td>-0.03</td>
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</tr>
</tbody>
</table>

Adj. R Sq. = .31 (p=.000)
*p<.05  **p<.01  ***p<.001

To summarize, all eight variables have a significant impact on some aspect of learning. However, coordination procedures, team performance, and lack of conflict have the most consistent across-the-board impacts. Shared team identity is relatively more important for PDT learning, whereas trust and awareness are relatively more important for EMIS learning.
macro/micro distinction of awareness [44]. Subteam leaders tend to be more aware of activity, availability and processes regarding their distant subteam, while members within a given subteam have a more general impression of distant team capabilities rather than intricate awareness. However, in co-located subteams, students work side-by-side with one another, which naturally increases their within subteam awareness.

Perhaps most noteworthy is the distinction of circumstances pertaining to when trust and shared identity play key roles in successful team interaction. Trust has long been recognized as a key determinant in the successful interaction of distributed teams, in terms of both team performance and member satisfaction [26]. However, a more limited body of research suggests that establishing a shared identity – feeling like a member of the team -- is also essential, particularly in partially distributed teams. The split configuration of PDTs across multiple sites, such that a given subteam of co-located members shares the same context where members have face-to-face contact with one another, naturally increases the feelings of separateness between subteams [45]. Thus, negative feelings of “us vs. them” are the norm in teams with this partially distributed configuration. Teaching students how to collaborate in PDTs necessarily means providing them with the tools necessary to achieve a shared team identity. Our research indicates that reframing the concept of identity to span the boundaries of subteams to encompass the larger context of the team is a worthwhile endeavor. Our findings re-affirm the importance of identifying with co-located team members, as has been established in research on traditional teams. Thus, learning to work in a PDT involves identifying with one’s co-located subteam as well as one’s distributed team.

Establishing trust, especially personal trust, between subteams was important regarding EMIS domain learning. Observation of teams throughout the project indicates that most teams divided portions of deliverables between subteams, such that Subteam X would draft certain sections of a team deliverable while Subteam Y would draft other sections. Then, subteams would exchange their drafts for comments and editing by the other subteam. Given this draft cycle, it is understandable how personal trust played an important role in domain learning: to divide work, you must trust that others are going to do their portions of the deliverable. This is also true when divvying up work within a given subteam, which is probably the reason why one of the strongest predictors of EMIS domain learning is within subteam process trust, whereas that variable is not significant in the other three contexts.

Limitations: Our subjects were students, which is always a concern for generalizability. However, the tasks performed by the students were similar to those performed by professional software developers. Also, the project counted for a significant portion of the students’ grades (about 20% on the average), which motivated them to perform well. In addition, process trust data included in this analysis is only from one semester. Finally, all of the teams had the same two-subteam configuration. In the future, we plan to expand to include PDTs with three subteams, to discern what difference this may make for team interaction variables such as trust and shared identity.

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7. References

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APPENDIX

Learning Scales

Partially Distributed Team Learning:
Working on the PDT project:
• Increased my skills at working in a distributed team
• Increased my ability to team with others across distance
• Provided me with a real-world perspective on distributed teams
• Gave me a good hands-on experience at collaborating across distance

EMIS Domain Learning
Working on the PDT project:
• Increased my understanding of basic concepts of emergency preparedness
• Helped me learn factual material about natural disasters
• Helped me identify central issues in emergency preparedness
• Increased my ability to consider different requirements and design options
• Increased my confidence in expressing ideas
• Was more interesting than other assignments during my college career
• Was more time intensive compared to what I typically spend on course assignments

Team Interaction Scales

Coordination:
To coordinate member effort within my/between subteam(s), there were:
• Procedures for coordinating work
• Project milestones and delivery schedules
• Project documents and memos
• Regularly scheduled meetings (face-to-face and/or electronic)
Performance:
Compared with other teams you have worked on, use the following dimensions to rate the performance of your subteam/team:

- Efficiency
- Quality
- Creativity
- Adherence to schedule
- Coordination of member efforts
- Communication between members

Conflict:
- Much disagreement existed in my subteam, between subteams
- There was a great deal of personality conflicts in my subteam, between subteams
- A great deal of disagreement regarding project work existed in my subteam, between subteams
- We had difficulty with timing interactions between members (i.e., when members would work or consult with one another) in my subteam, between subteams
- We experienced interruptions or delays in the flow of work between members in my subteam, between subteams
- How much tension was there among members within your subteam/between subteams.
- How much emotional conflict was there among members within your subteam/between subteams.
- How frequently were there conflicts about ideas within your subteam/between subteams.
- How much conflict about the work you did was there within your subteam/between subteams.
- To what extent were there differences of opinion within your subteam/between subteams.

Awareness:
- I was aware of the activities members were working on in my subteam, distant subteam.
- I was aware when members were available to meet (either electronically or face-to-face) in my subteam, distant subteam.
- I was aware of what needed to be done next in my subteam, distant subteam.

Capability:
- I felt very confident about the members’ skills in my subteam/distant subteam.
- Members were very competent in terms of completing this project in my subteam/distant subteam.
- Members were quite capable of performing the necessary tasks in my subteam/distant subteam.

Personal Trust (Trust One):
- Even if I could not monitor them, I was comfortable giving a critical task or problem to other members in my subteam/distant subteam.
- I felt that members were honest with me in my subteam/distant subteam.
- I felt that members negotiated joint expectations fairly in my subteam/distant subteam.
- Even if I could not monitor them, I was comfortable giving a critical task or problem to other members in my subteam/distant subteam.
- I felt that members kept their word in my subteam/distant subteam.
- I felt confident that members would not exploit me in my subteam/distant subteam.

Process Trust (Trust Two):
- I felt that members tried to get the upper hand in my subteam/distant subteam.
- I would have preferred if some members had less influence over important aspects of the project in my subteam/distant subteam.
- I wanted to more closely monitor the work of members in my subteam/distant subteam.
- I felt that members tried to get out of their commitments in my subteam/distant subteam.

Shared Identity
- I feel loyal towards my subteam/team.
- I see myself as a member of subteam/team.
- I am proud to think of myself as a member of subteam/team.