A Comparison of Team Developmental Stages, Trust and Performance for Virtual versus Face-to-Face Teams

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Abstract

This study is an empirical analysis that compares virtual with face-to-face teams on team trust, performance issues and team developmental stages. The study uses data collected both before teams were formed and after teams completed their project deliverable. Pre-task measures include individual disposition to trust and initial team trust. Upon completion of their deliverable, team members responded to post-task measures on motivation, team trust and teamwork dynamics. In addition to these attitudinal comparisons, we investigate how teams spent their time during the completion of their team task. We examine potential differences in the percentage of time spent in each of the classic team formation stages (forming, storming, norming and performing). Team members also reported the total time spent completing the deliverable as well as time spent using various communication tools. In addition, we evaluate and compare team performance in terms of the deliverable quality. Our results indicate that both virtual and face-to-face teams bring relatively high initial trust to the team experience. More enduring trust, however, must be maintained by positive, task-oriented team dynamics. Team mates need to meet work expectations in order to maintain the trusting environment. We confirm that trust is important to team performance for both virtual and face-to-face teams. Higher trust teams do tend to perform better. We also found that both virtual and face-to-face teams spend similar proportions of time in each team formation stage. Finally, there is no significant difference in results produced by face-to-face and virtual teams, though in this study the direction of effectiveness leans towards the virtual teams. This is potentially good news since many believe that face-to-face groups produce better results than their virtual counterparts.

1. Introduction

Teamwork is considered to be some of the more important work done in today’s organizations (see, e.g., [17]. In fact, organizations presuppose teamwork. Without teamwork at some level of cooperation, organizations cannot exist. Teams are considered to be the “standard operating procedure” in most high tech organizations and teams have become an important topic of study in the last decade. Advances in information and communications technology have enabled teams to work together in a virtual environment on tasks that at one time were assumed to require face-to-face meetings. The enabling of virtual teamwork occurred in parallel with competitive pressures that have forced many companies to shorten product development windows and reduce costs by outsourcing internationally. Organizations increasingly view virtual teams as a means to increase their flexibility and responsiveness while reducing costs [6]; [7]; [10]; [16].

Business practice in virtual team usage, by necessity, has preceded extensive research on its impact in the workplace. How does the business value of using virtual versus face-to-face teams (or a combination of the two) compare when considering work quality and efficiency? What are the social dynamics of virtual versus face-to-face teams? Do the two types of teams move through team developmental phases [20] at a different rate? Does working virtually have an impact on trust? The increasingly large volume of books and articles on virtual teams and their management contains very little empirical investigation of these and other questions. There are many more hypotheses about how virtual teams work than empirical studies to address them. This lack of empirical evidence motivated us to develop the study described in this paper. Specifically, we investigate possible differences in the pattern of team developmental stages. We further compare virtual with face-to-face teams on the trust brought to the
team (prior to working together) as well as the level of trust maintained by the end of the project. Finally, we compare team performance for the two team work environments.

2. Background

2.1 Team Types and Task Complexity

One of the defining characteristics of a virtual team is that it has a distribution of team members across time, geography or both. Virtual teams rarely (or never) meet face-to-face and depend on information and communications technology for their coordination and collaboration [2]. Virtual teams can be characterized by their cultural/geographic similarity, temporal distribution and life cycle [2]; [11].

Clearly, the task or project responsibilities charged to a team can vary widely in complexity. Bell and Kozlowski [2] cite the levels of team interdependency set out by Thompson [19] and further refined by Van De Ven, Delbecq and Koenig [21] as important measures of team task complexity. The least complex team tasks are designated as pooled/additive. In these tasks, team members can work for the most part independently with their results being brought together to form the finished product. The second level of team interdependency, sequential, involves unidirectional work flows among team members. Bidirectional work flows require more coordination and collaboration and are labeled reciprocal. The most complex form of interdependency, intensive, occurs when work involves diagnoses, creation and/or problem solving that require simultaneous team involvement.

When teams are virtual, their temporal and life cycle characteristics are influenced by the level of team task interdependency. Virtual teams are able to work asynchronously on pooled/additive or sequential tasks without significant problems but typically need to align the temporal dimension to handle more complex interdependencies. Further, the stronger the work flow interdependency, the less likely the team is to have a short life span [2]. Teams whose missions involve intensive interdependencies tend to work synchronously and have relatively long-term assignments.

McGrath and Hollingshead [13] describe four task classifications of increasing information requirements and complexity:

- Generating ideas and plans (brainstorming)
- Making choices in situations with and without right answers
- Negotiating or resolving conflicts of opinion and/or interest
- Executing plans (which includes negotiating differences in power)

They further delineate a continuum of communication media richness than extends from computer tools to audio, video and, finally, face-to-face (see also [10]). The general thesis is that the more complex the task, the richer the communication medium must be in order for the team to handle it successfully. For virtual teams, this implies that more complex tasks typically require synchronous, information rich electronic team environments [2].

Wilson [22] found supporting evidence of McGrath and Hollingshead’s [13] task/media fit hypothesis in his study of email effectiveness. He assigned team tasks that required either low or high amounts of interaction. Both the low and high interaction teams found email to be effective for generation tasks and less effective for choice, negotiation and execution tasks. The negative response for the fit of email with choice, negotiation and execution tasks was considerable stronger, however, for the high interaction teams.

2.2 Team Trust

There is general agreement that high trust teams are more effective than low trust teams [3]; [12]. For this reason, the dynamics of trust in virtual teams are the subject of great interest and increasing study. Some doubt that trust can flourish in the absence of face-to-face contact [4]; [5]; [10]. Others maintain that virtual teams can experience high levels of trust if they establish “swift” trust [15] enhanced through early proactive communication that they maintain with positive task-related action [8]; [12]. “Swift” trust is based largely on the role-based reputation of team members and may be at its height at the beginning of the team experience [15] if not sustained by later team contributions.

Jarvenpaa and Leidner [8] studied in detail the electronic communications of the highest and lowest trust teams in their study of global virtual teams. The high trust teams sent early, positive email messages and kept a strong, sustained focus on action and task results, reinforced by frequent communication. In contrast, the low trust teams were markedly less active throughout their life cycle.

2.3 Performance Issues

While it is generally accepted that virtual team work has considerable cost and flexibility benefits, some question whether the benefits outweigh possible
performance losses arising from virtual versus collocated work [1]. Prior research on computer-mediated groups may provide some clues regarding performance for virtual teams [2]. Computer-mediated groups tend to perform better than face-to-face groups on idea generation tasks but worse on more complex tasks with computer-mediated groups typically having longer task completion times [13].

Research on virtual team performance to date has tended to follow the same pattern as earlier work on computer-mediated groups. Andres [1] compared the performance of software development teams using videoconferencing versus face-to-face work in a controlled time setting. The face-to-face teams had considerably higher performance in this setting, which was controlled to force collaboration and prohibit low level team interdependencies at the pooling/additive and sequential levels. Potter and Balthazard [18] studied performance on a team task involving the formation of team rankings of biomedical and behavioral research practices in terms of their acceptability. The face-to-face teams performed better on almost all task outcomes.

2.4 Developmental Stages

The classic team formation phases [20] are forming, storming, norming and performing. Team members get to know each other in the forming stage. They understand the value of each person on the team and how each person’s work affects (and is affected by) the work of others. What follows is the storming stage, where individual differences surface and conflicts arise. It is important to note that it is nearly impossible to get to a performing stage without going through the storming phase. Individuals develop commitment to each other and the project as they surface and address the issues that keep them apart. Once storming has occurred, the group begins the norming stage where members settle into a synergy of common processes and ways to handle conflict and issues. Once conflict can be resolved and the atmosphere is cleared for open communication, the group members can focus on the task and performing becomes the normal mode of operation. Productivity in the last stage is much higher than in the first three stages of team formation.

There is no clear indication at this point whether virtual teams tend to pass through these stages in a similar fashion as collocated teams. Forming and storming are thought to be the most challenging stages for virtual teams [9] with storming taking longer for virtual teams [12]. Young [23] suggests that forming and storming may be best facilitated face-to-face or if this is not possible, synchronously via video conferencing.

3. Research Questions and Hypotheses

3.1 Initial Team Trust

Jarvenpaa and Leidner [8] confirm that an individual’s disposition to trust positively affects his/her team trust (with measurements taken after the team experience began). They measure the amount of “swift” trust attained but not the initial trust imported into the team experience, thus leaving an open question of the initial amount of team trust held by their global virtual teams. We address this question by observing the amount of initial team trust for both virtual and face-to-face team members and testing for any differences, adjusting for an individual’s disposition to trust. We found no relevant studies on initial team trust and thus have a two-tailed hypothesis.

\[ H1: \text{Virtual versus face-to-face team members differ in their initial trust levels, controlling for disposition to trust.} \]

3.2 Enduring Team Trust

Do virtual teams, in general, experience depressed levels of trust due to their lack of “touch” [5]? Do positive team actions promote enduring trust? Given individual disposition to trust and initial team trust, we test whether virtual teams tend to have lower levels of enduring team trust (measured at the end of the team experience).

\[ H2: \text{Virtual teams have lower enduring team trust than face-to-face teams, controlling for disposition to trust and initial trust levels.} \]

We further test if team dynamics have a positive relationship with enduring trust.

\[ H3: \text{Positive team dynamics are positively related to enduring team trust.} \]

3.3 Total Task Time

Research on computer-mediated groups indicates that they tend to take longer to complete assigned tasks than face-to-face groups. Task time has two dimensions. The first relates to the task duration (difference between the start and end time for the task). The second involves the total amount of team resource time taken to accomplish the task. The task in our study had a fixed beginning and end date so we can only evaluate the total time expenditure. We test to see if the virtual teams average a higher total task time, adjusting for team motivation.
3.4 Team Performance

Prior research suggests that virtual teams may have diminished performance relative to face-to-face teams. Further, for both types of teams, there is evidence that team trust increases performance. We test for a negative impact on performance for virtual teams and a positive impact of team trust on team performance for both types of teams, adjusting for the total time the team spent on the task.

\( H5: \) Virtual teams’ task performance is worse than face-to-face teams, controlling for total time on task.

\( H6: \) Team trust is positively related to team performance, controlling for total time on task.

3.5 Developmental Stages

There is conjecture that forming and storming are more challenging for virtual teams and that storming may take longer for virtual teams. We found no discussion of the other two stages. Based on this, we hypothesize that virtual teams may spend a larger percentage of time on forming and storming.

\( H7: \) Virtual teams spend a larger percentage of time than face-to-face teams in the forming stage.

\( H8: \) Virtual teams spend a larger percentage of time than face-to-face teams in the storming stage.

4. Methodology

From June through December 2002, one of the coauthors (and instructor of the MIS option undergraduate capstone class at California State University Chico) participated in a virtual team that researched how various collaborative products were used within SAP Labs, a multi-national software development company. This experience formed the basis of an assignment designed to simulate a virtual team experience so that students in the capstone class could better understand virtual teams by participating in a virtual team experience versus just reading about it. The project (research and document a product used to support virtual teams) given to the student teams was an abbreviated version of the larger project (research and document all products used by SAP Labs to support virtual work) done by the SAP Labs virtual team of which the instructor was a member.

The experiment had two phases: an exploratory exercise done in Fall 2002 and a more experimental exercise completed in Spring 2003. Drawing on the SAP Labs experience, the instructor divided the Fall 2002 class into teams and asked them to complete an assignment without meeting face-to-face. The assignment was to research a product with respect to its ability to support collaborative systems development in a company scenario defined by the instructor. The instructor provided each member of the 3-4 person team different aspects of the assignment. In order to complete the assignment successfully, all participants needed to be contacted, at least share what they knew about the assignment with the other team members and then complete the assignment.

The deliverable turned in by each team in Fall 2002 included a written summary of the product research along with an evaluation of the virtual team experience that contained mostly open ended questions. There were 48 students who participated in the experiment and nearly a third mentioned that the 48 hours given for the assignment completion was not enough time to contact everyone and get the work done. Everyone used email for contact and 41 of the 48 also communicated via telephone. Half of the students used some sort of online chat tool or instant messaging.

Based on the results and feedback, the assignment was fine-tuned, questionnaires were developed and a more formal study was conducted in Spring 2003. For this study, we gave two sections of the undergraduate MIS option capstone course (with 37 and 41 students) the revised product evaluation assignment. The assignment was identical except that in one class section the students were allowed and encouraged to meet face-to-face, and in the other they were instructed not to meet face-to-face. Remaining aspects of the assignment such as due date (a week was allowed this time), research topics, team size, and the division of assignment information among team members were the same in both treatments. Students in both groups had unrestricted access to communication media including email and instant messaging. Although they were not prohibited from using richer media, we did not provide anything other than email access.

We arbitrarily assigned students to teams and team assignments within the team except for intentionally putting friends and roommates on different teams. The team leader, randomly assigned by the instructor, received the names of all the team members along with the “rules of engagement” for the exercise. Another team member received the name of the product that was the subject of the assignment. We provided the remaining team members with the company scenario in which the product would be used and specific instructions about what the team needed to do.
to turn in for assignment credit. Within each team, no team member received the same information as any other team member. No team within each treatment was given the same product to research so teams had to rely only on their teammates to understand and know all the aspects of the assignment.

We administered a pre-test questionnaire that included validated disposition to trust items [13] as well as a measure of initial team trust with all ratings using a seven point scale. We used the pre-test to determine the students’ general predisposition towards trusting teammates and initial team attitudes towards the team (prior to knowing their team members’ identities). Students completed a post-test survey containing measures of team trust and team dynamics (related to task accomplishment) after the team project ended. On the post-test, students also responded to open-ended questions regarding team developmental stages, tasks performed, total time expenditure and time spent using communication tools.

Students completed the pre-test questionnaire after the assignment was explained and they had received their respective team assignments (but did not yet know who their team members were). Therefore the participants knew whether they were on a face-to-face or virtual team at the time they responded to the pre-test. We coded teams and team members with a number identifying the team member number, i.e. team leaders were team member 1, the team member who knew the product to be researched was team member 2, etc. While questionnaires were coded with team and team member identifiers, from the student perspective and for the purposes of analysis, responses to the questionnaires were anonymous.

When the assignment results were collected a week later, students completed the post-test questionnaire. As students turned in the assignment, their team number and team member number were recorded so they could be matched with the pre-test data. (This also was used to determine who participated in the assignment for grading purposes in the class.)

The instructor assigned a random number for each assignment, a 3-4 page report, used in scoring by two independent researchers without knowledge of which teams were virtual. The evaluators scored the reports using a 10-point scale assigned to each of four requirements for the paper (the maximum score for the paper was 40 points). Evaluators were instructed to score the reports with respect to completeness and understandability of the four assignment requirements, as follows:

- Describe what the product is,
- Explain how it is used within collaborative software development environments in general,
- Describe how the product can be evaluated with respect to meeting the needs of the simulated company or report the actual results of the evaluation if the team decides to do this, and
- Give an opinion on how well the product can be used to support collaborative work within the simulated company.

5. Results

5.1 Initial Team Trust

We created an index using the disposition to trust measures of McKnight, Choudhury and Kacmar [14] after calculating their Cronbach’s alpha value (.85). After adjusting for disposition to trust, we found no evidence of a difference in initial team trust between virtual and face-to-face teams (H1 not supported, p-value=.816). The unadjusted sample means for both groups are 5.8 (on a 7 point scale), indicating a high level of initial trust.

5.2 Enduring Team Trust

We conducted a hierarchical regression to test whether virtual teams tend to have a depressed level of enduring trust, controlling for disposition to trust and initial team trust level. We added an index of task-related team dynamics (Cronbach’s alpha = .82) to capture whether or not the individual team member perceived the team positively with respect to its task-related actions. Model 1 contains the disposition to trust and initial team trust variables, Model 2 adds the virtual team dummy variable and Model 3 adds the team dynamics variable. Results are given below.

<table>
<thead>
<tr>
<th>Table 1. Model summary</th>
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<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
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<table>
<thead>
<tr>
<th>Model-3</th>
<th>B</th>
<th>Beta</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
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<td>-.621</td>
<td>.5368</td>
<td></td>
</tr>
<tr>
<td>Trust</td>
<td>.363</td>
<td>.207</td>
<td>1.848</td>
<td>.0695</td>
</tr>
<tr>
<td>Pretrust</td>
<td>.326</td>
<td>.227</td>
<td>2.044</td>
<td>.0453</td>
</tr>
<tr>
<td>Virtual</td>
<td>.317</td>
<td>.118</td>
<td>1.051</td>
<td>.2972</td>
</tr>
<tr>
<td>Teamdyn</td>
<td>.451</td>
<td>.440</td>
<td>3.884</td>
<td>.0003</td>
</tr>
</tbody>
</table>

Dependent variable = Posttrust
The addition of team type (virtual/face-to-face) added very little to the $R^2$ value (insignificant with p-value=.677). The team dynamics variable has a highly significant positive effect on enduring trust. Our results do not support the hypothesis ($H2$) that virtual teams tend to have lower trust. On the other hand, we show strong support for the idea that the better job the team does at taking positive action, the higher the trust level will be maintained ($H3$).

5.3 Total Task Time

We asked each team member to record the number of hours spent individually on the project. We then summed these across all team members to determine a total human resource usage for the project. The face-to-face teams in our sample averaged 11.7 hours while the virtual teams averaged 10.5 hours. After adjusting for average team motivation level (index from three measures, Cronbach’s alpha=.80), the sample difference is not significant (p-value = .688). Our results do not show significantly longer task times for virtual teams ($H4$).

5.4 Team Performance

Two independent raters scored the team reports on a scale from 0-40, as described in the Methodology section. We averaged their scores to obtain the team performance indicators. We present the following performance results with the caveat that the inter-rater reliability is not high (alpha=.39). We ran a hierarchical regression entering the total team time spent as a control (Model 1), followed by the virtual dummy variable (Model 2) and finally the enduring team trust (average for team) in Model 3. Results follow.

Table 2. Model summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R-Square</th>
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<tbody>
<tr>
<td>1</td>
<td>.379</td>
<td>.094</td>
</tr>
<tr>
<td>2</td>
<td>.413</td>
<td>.066</td>
</tr>
<tr>
<td>3</td>
<td>.768</td>
<td>.508</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model-3</th>
<th>B</th>
<th>Beta</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-4.813</td>
<td>-.731</td>
<td>.4760</td>
<td></td>
</tr>
<tr>
<td>Team Hours</td>
<td>.389</td>
<td>.398</td>
<td>2.387</td>
<td>.0310</td>
</tr>
<tr>
<td>Virtual</td>
<td>2.446</td>
<td>.252</td>
<td>1.500</td>
<td>.1540</td>
</tr>
<tr>
<td>AvgPost-Trust</td>
<td>4.288</td>
<td>.654</td>
<td>3.916</td>
<td>.0010</td>
</tr>
</tbody>
</table>

Dependent variable = AvgPerf

The addition of the virtual team dummy variable to the model containing the team total hours brings a small increase to $R^2$ and is insignificant (p-value=.486). Further, in the final model, the sign on the virtual team coefficient is opposite that expected if virtual teams tend to perform worse (p-value=.923). Our evidence strongly contradicts the hypothesis ($H5$) that virtual teams perform worse, on average, than face-to-face teams. On the other hand, the team’s average enduring trust is highly positively related to the team performance, confirming the general consensus that higher trust teams perform better ($H6$).

5.5 Developmental Stages

When we tested for differences in the percentage of time spent in each of Tuckman’s [20] four developmental stages, we found none of the following differences to be significant (smallest p-value = .351), providing no evidence that virtual teams form and storm longer ($H7$, $H8$). It may be of interest to note that the elevated Forming % for the virtual teams is due in part to one team spending an estimated 96% of their time forming.

Table 3. Developmental stages

<table>
<thead>
<tr>
<th>Team Process Stage</th>
<th>Face-to-Face Teams</th>
<th>Virtual Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forming</td>
<td>21%</td>
<td>30%</td>
</tr>
<tr>
<td>Storming</td>
<td>19%</td>
<td>18%</td>
</tr>
<tr>
<td>Norming</td>
<td>19%</td>
<td>17%</td>
</tr>
<tr>
<td>Performing</td>
<td>40%</td>
<td>35%</td>
</tr>
</tbody>
</table>

5.6 Communication Media

We have no formal tests for tool usage and present this section as descriptive solely. We obtained the following results for the communication tools used by the students in each group.

Table 4. Communication media

<table>
<thead>
<tr>
<th>Communication Medium</th>
<th>Face-to-Face Teams</th>
<th>Virtual Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>33 Minutes</td>
<td>67 Minutes</td>
</tr>
<tr>
<td>Phone</td>
<td>4 Minutes</td>
<td>9 Minutes</td>
</tr>
<tr>
<td>Instant Messanger</td>
<td>3 Minutes</td>
<td>21 Minutes</td>
</tr>
<tr>
<td>Face-to-Face</td>
<td>67 Minutes</td>
<td>0 Minutes</td>
</tr>
</tbody>
</table>

The richest communication medium that the students used is Instant Messanger. Its use for the
virtual team is seven times higher than the face-to-face teams, indicating that virtual teams used its synchronous capabilities as this was the only medium with this type of option.

6. Discussion

This study provides some empirically-based insights into questions regarding work done and relationships formed in virtual versus face-to-face team environments. While trust is important to all teams, the results here reinforce the idea that trust is related to what a person does on the team and that high trust needs to be created and maintained early. In other words, people may tend to start out trusting others, but members of both types of teams need to meet work expectations early in order to maintain the trusting environment.

It appears that both virtual and face-to-face teams spend similar proportions of time in each team formation stage. While the task in this study is relatively short, team members still identified time spent on each stage. In future studies it might be interesting to link the stages with tools used. It appears that Instant Messaging (IM) may be a substitute for virtual teams who do not have face-to-face time and questions remain as to the effectiveness of IM to help with the stages.

Perhaps the most interesting finding is that related to effectiveness. While there is no significant difference in results produced by face-to-face and virtual teams, in this study the direction of effectiveness leans towards the virtual teams. This is potentially good news, since many believe that face-to-face groups produce better results but that companies merely “get by” with virtual teams because they are a less expensive alternative. There is potential for future research in this area in terms of examining whether there are some situations where virtual teams are more effective than face-to-face teams.

One potential limitation of our study is the ability to generalize the results to a corporate setting, since we used students as subjects in our study. We feel that we were able to control our experimental environment much more carefully than would be possible in a business environment. In essence, we made a trade-off between “realistic” and “controllable” in terms of our research design. However, future research examining the same dynamics in a corporate setting would be very helpful in terms of validating our results in a more realistic environment.

Another limitation that confounds our performance results is that the task in the study is closer to the sequential end of the interdependency spectrum, not necessarily requiring heavy collaboration. This may tie in with the fact that all of the face-to-face teams gave written evidence of collaboration while only six of the nine virtual teams did. Future studies should look at longitudinal teams and collect data related to different kinds of tasks.

7. References


