A meta-analysis of the consequences of virtualness on team functioning

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A B S T R A C T

Virtual teams in organizations have now become a reality, but there have been only a handful of quantitative reviews on "virtualness" (i.e., teams that are more or less virtual). We decided to conduct a meta-analytic review of the effects of virtualness on team functioning (conflict, communication frequency, knowledge sharing, performance, and satisfaction). To explain inconsistencies in the results of published material on the topic, we also examined the moderating effects of level of analysis (individual/group), method (experiment/survey), and time frame (short/long). Eighty studies were found that covered some part of this domain. Results seem to differ in the relative importance of the factors. Thus though aggregated findings suggested negative effects of virtualness on team functioning, results varied in strength and direction of the moderators, indicating that it was not possible to generalize. For example, the negative effects held only for short-term teams, while in longer-term teams the effects weakened or disappeared.

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1. Introduction

The practice of using virtual teams in organizations has become popular. Thus, it is important to organizations and team researchers to understand how "virtualness" affects team performance. We decided to review the empirical research on this topic through a meta-analysis.

Virtual teams have been defined as groups of individuals who work together in different locations on interdependent tasks, sharing the responsibility for outcomes, while relying on technology to provide most of their communication. While early virtual team research usually examined "virtualness" as a dichotomy, either face-to-face or computer-mediated (without physical interaction), virtualness has evolved to include degree of separation of members (distance), proportion of members who work virtually (configuration), and the proportion of time that team members work apart. We adopted Schweitzer and Duxbury's [19] suggestion that "to be considered virtual, a team must have some members who do not work in either the same place and/or at the same time, and therefore, cannot collaborate face-to-face all of the time". Thus, we focused on the *degree of virtualness*, a continuum, ranging from not at all virtual to highly virtual. We only included articles in our study that measured or varied one or more dimensions of virtualness.[3] In doing so, this article differs from others that included articles that do not assess or vary the level of virtualness [16] or that do not analyze the relationship between virtualness and other variables [10].

Narrative reviews of the literature have highlighted inconsistent findings, such as positive and negative [e.g., 7] relations between virtualness and performance. Understanding why such inconsistencies exist could help practitioners. The narrative reviews have also pointed out a predominance of certain types of studies, such as short-term experimental research, and question whether the results are generalizable. In contrast, quantitative reviews, such as meta-analyses, help to address these inconsistency issues and questions.

Meta-analyses quantitatively integrate results reported in existing studies. The analysis increases the power of the conclusions made on the relations between variables. Unlike narrative reviews, meta-analyses adjust for sample size and the reliability of measures, thus providing better estimates of the

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[3] We excluded articles that did not have either a measure of virtualness or a comparison of virtual with face-to-face teams. Neither did we quantitatively review articles at other levels of analysis, such as virtual communities or organizations, as this would confound the results.

relations between variables. They also allow for the discovery of moderators through the coding of differences between studies. Thus, progress in theory building and cumulative knowledge is achievable with meta-analysis.

The objectives of our meta-analysis were to: (1) examine the extent to which virtual teams research has built cumulative knowledge, (2) quantify the strength of the relationships between virtualness and team processes and outcomes, and (3) explore reasons for contradictory findings.

2. The consequences of virtualness

To examine the effects of virtualness in teamwork, we used the well-known input–process–output (IPO) model that includes *input factors* such as team member characteristics, team- and organizational-level architecture, contextual information, and virtualness; *processes* which are the interactions between team[4] members or communications from individuals involving teamwork, that may be either expressive (interpersonal) or instrumental (task-related); and *outputs* that measure team effectiveness, such as performance on the task or the satisfaction of group members.

The IPO model has been modified as more has been learned about team effectiveness; for example, some mediating mechanisms, initially considered processes, have been identified as emergent states (e.g., cognitive, motivational, or affective states such as potency and cohesion). Therefore, the general term *mediator* is used to describe processes and emergent states. Time has also been recognized to have an important role, which was not captured well in the IPO model. These changes have led to an IMOI (input–mediator–output–input) framework [14]. Within this new framework, it is possible to explain the effects of virtualness on mediators and/or outcomes with the theoretical perspectives of media richness/social presence, attribution theory, and categorization.

Today, groups are more likely to be dispersed, with electronic communication dominating their interaction. Media richness and social presence theories suggest that such communication is less personal, with fewer nonverbal cues. Also, attribution theory suggests that people try to explain their own or others' behaviors by making two types of casual attributions: internal (dispositional) or external (situational). A person's initial attribution of another's behavior is usually dispositional (i.e., the fundamental attribution error) and then corrected, depending on knowledge of the person and/or situation. Virtual teams are likely to make attribution errors because members have less knowledge of their teammates and their environments. Thus there is potential for attribution errors to go uncorrected [6]. Categorization provides a third theoretical perspective: social identity theory, self-categorization theory and the similarity/attraction paradigm all suggest that people categorize themselves into subgroups according to salient cues. Individuals identify more closely with people they perceive as being similar to themselves [5]. In virtual team settings, subgroups may develop. As in- and out-group characteristics become salient in subgroups, individuals become more biased towards their own subgroups [20].

3. Development of research questions and hypotheses

Virtualness is the only input variable we examined. Considering the number of mediator and outcome constructs, the number of possible relationships is quite large. We searched the literature for empirical studies related to virtual teams. Whenever virtualness was included in a study and its relationship to a mediator or outcome variable had been examined in at least one other study,

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[4] We use the terms *team* and *group* interchangeably.

the mediator/output variable was included in our meta-analysis. Therefore, our first general research question was:

> **Question 1:** What are the strengths and directions of the relationships between virtualness and team mediators and outputs?

We also examined the generalizability of the findings. Specifically, by introducing moderating variables, meta-analysis techniques can determine whether between-study differences were partially due to the different conditions in the moderator variables. Research designs and sample characteristics are typical moderators examined in meta-analysis work. Accordingly, three possible moderators that varied most frequently across the primary studies were investigated: the level of analysis (individual versus group), the study method (experiment versus survey), and the time the teams worked together (short versus long-term). Therefore, our second research question referred to moderators:

> **Question 2:** To what extent do level of analysis, study method, and/or time duration moderate the relationships between virtualness and team processes and outputs?

To investigate these questions, we developed specific hypotheses about the effects of virtualness on the selected mediators and outcomes. The choice of processes and outcomes to include in our meta-analysis was driven by three factors. First, we needed typical processes and outcomes to be represented. Second, we were restricted to situations in which multiple empirical studies on the relationship between virtualness and a specific variable existed. Third, we wished to focus on variables where the empirical results were ambiguous, so that our meta-analysis would help to clarify them. Three mediating variables (conflict, communication frequency, knowledge sharing) and two output variables (performance, and satisfaction) met our criteria.

3.1. Main effect hypotheses

Conflict represents perceived discrepancies, incompatible desires, and wishes of the parties involved in a team. Conflict may be divided into three types: relationship conflict (the affective component of conflict that concerns the awareness of incompatibilities in the interpersonal realm); task conflict (differences in opinions about a group task); and process conflict (differences of opinion about the way a task should be performed). Researchers have used conflict measures with labels such as: proportion of disagreement, personal attacks, tension, task conflict, process conflict, relationship conflict, affective conflict and general conflict, or a combination of these. All three types relate to virtual team functioning [9]. For example, it can be argued that moderate task conflict can be beneficial because it results in discussion that can provide a better solution to solve the task. Indeed, Massey et al. [13] found that more productive virtual teams experienced more conflict. However, many studies find that the three types of conflict inter-relate strongly but negatively to team functioning [e.g., 8].

We therefore expected that those in more virtual teams will experience more conflict, while those in less virtual teams enjoy more face-to-face communication, resulting in more informal interaction and socialization. This is likely to result in greater rapport and collaboration, stronger team identity, and lower conflict. Because of distance between team members, conflict is difficult to manage in more virtual teams. Differences in work location can also lead to the formation of in-groups and out-groups within teams. Thus, conflict typically arises between the subgroups due to favoritism of local members.

Although most studies found positive relations (higher conflict for more virtual teams), a few have demonstrated a negative