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Identifying Potential Leaders for Virtual Teams

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Abstract

Virtual teams are becoming more common work structures because specialized knowledge is often geographically distributed. The performance of virtual teams can be increased through effective leadership. Although a growing body of research exists that has identified behaviors exhibited by effective virtual team leaders, we know relatively less about the characteristics of workers or their prior experiences that make them more likely to exhibit these behaviors. Our research seeks to address this gap by examining how the prior technological and interactional experiences of leadership candidates is related to the leadership behaviors that they exhibit during virtual team work. Our results indicate that prior experience working in virtual teams, particularly with the technologies that support the virtual work, are the most significant factors that predict leadership behaviors. Our results have implications for improving current leadership training programs and for providing effective leadership in existing virtual teams.

1. Introduction

Virtual teams (VTs) are becoming common work structures because they can leverage geographically distributed, specialized knowledge that is required for the execution of complex projects in fields such as software development or engineering [1, 2, 3, 4]. Cooperative decision-making in VTs can be challenging [5] and as conflict is common [6], trust is difficult to establish [7]. However, as in traditional work contexts, many of the challenges for VTs can be addressed by effective leadership [8].

Research has begun to explore the relationship between effective leadership in traditional teams [9, 10, 11] and VTs [12]. Although a growing body of research exists that has identified behaviors exhibited by effective VT leaders [13], we know relatively less about the characteristics of workers or their prior experiences that make them more likely to exhibit these behaviors. We do not know whether effective leaders in traditional, co-located work contexts will be effective leaders in virtual contexts or whether workers with distributed team experience are more likely to be effective leaders in distributed work settings. Thus, we know what effective virtual leaders do, but we lack much of the knowledge required to identify potentially effective candidates for leadership roles in VTs. To this end, our research explores the relationship between workers' previous experiences and the likelihood that they will exhibit effective leadership behaviors.

2. Background

Research on effective leadership has highlighted the interpersonal and technological behaviors that effective leaders exhibit in well-functioning VTs. While interpersonal behaviors such as rapport building [15, 16] and creating work assignments [17, 18] may transfer from traditional team leadership to virtual teams [19], technological behaviors such as troubleshooting [20] and establishing a shared context [13, 16] are unique to virtual teams. Taken together, this research has attempted to determine which leadership behaviors improve the task performance and the team dynamics of VTs [15].

2.1. Interactional leadership behaviors

Effective leaders encourage *rapport building*, which encompasses a collection of behaviors aimed at creating a congenial and positive atmosphere where team members can feel comfortable interacting with one another [13, 21]. Rapport building is especially important during the early stages of collaborative work [16, 20] as it can lead to the formation of trust, which can emerge when networks have a shared sense of purpose and values [15].

Teams that display a high level of trust also have high levels of group *solidarity*, which occurs when members identify strongly with other team members. Effective leaders facilitate this collective identity by clarifying how every team member's role fits within the overall goal of the team [15].

Effective leaders also exhibit high levels of *engagement* as they maintain consistent interaction with team members throughout the life-cycle of a

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project [16], in part, because participation can lead to social influence [22]. Lapses in leader engagement can result in confusion, decreased motivation and lack of engagement by the other team members.

In addition to supporting communicative interactions, effective leaders also support work processes by structuring interactions between workers and their project tasks in the form of *assignments*. Through assignments, effective leaders clarify and define the scope of tasks and team member roles, delegate tasks, assess task progress, and provide feedback throughout the project lifecycle [15, 16, 17, 18, 20].

2.2. Technological leadership behaviors

Effective leaders in VTs must be able to perform *troubleshooting* and aid team members in identifying and resolving technological conflicts. Research has demonstrated that expertise with new communication media by workers is an important driver for team success [20]. Thus, VTs leaders can be more effective if they are able to help teams identify and resolve technological issues, particularly in distinguishing between cases where technologies have failed and cases where the team has failed to use the technology appropriately.

Because workers in VTs are geographically distributed, research has demonstrated that *shared context* is difficult to establish [6], which is an important condition for trust to develop [7]. Malhotra et al. [13] argue that actions (such as head nodding for agreement) need to be made explicit in virtual settings, which requires the creation of new communication norms. This idea highlights the need for the active creation of a shared interactional context in VTs, as visual cues that indicate action (and realization of expectation) in physical settings are largely absent in virtual settings.

2.3. Prior experience

Although research has identified a number of behaviors that are exhibited by effective leaders in both virtual and collocated networks, as Hertel et al. [20] note, there is still a lack of research that allows talent evaluators and human resource personnel to identify existing workers or new hires for leadership roles in VTs. Thus, our research responds to this gap as we seek to determine whether a potential leader's previous experiences are more likely to lead to their exhibition of the effective leadership behaviors described in Sections 2.1 and 2.2.

We focus on four aspects of a leadership candidate's previous interpersonal and technological experiences to explore associations between these types of experiences and the interpersonal and technological behaviors required of effective VT leaders. We are interested in determining whether interpersonal experiences such as *leadership training* for traditional teams and amount of *industry work experience* in addition to amount of technological experiences that candidates have had working in *distributed teams* and with the specific *technology of interaction*, i.e. the technological medium through which the interactions will occur. We assume that all of these experiences will have some impact on a candidate's exhibition of leadership behaviors and are interested in developing a more nuanced understanding of whether combinations of experience types are more likely to lead to exhibition of more leadership behaviors. Moreover, our study aims to examine how strongly the effects of previous experiences are on leadership behaviors. Thus, we posit the following research question:

What are the relationships of prior interpersonal and technological experiences with the exhibition of effective leadership behaviors in VTs?

3. Experimental design

In order to observe the leadership behaviors of VT members, we conducted an experiment designed to simulate the interactional dynamics of VTs enacting civil engineering project work. 4 VTs consisting of 5 graduate students were created based on enrollment in graduate courses in civil engineering. Students in each network were physically located at two large research universities in the United States. As a component of their coursework, the students were learning to develop construction schedules at one university and 4D Building Information Models (BIM) at the other. A 4D BIM maps a construction schedule to an architectural drawing to visualize how a building will be constructed over time. Over a three-month period, the VTs met for 2.5 hour work sessions each week and were tasked with the execution of the design and planning of a hypothetical construction project.

The research reported in this paper focuses on a four-week sample of interactions, including: a) the second week, where the networks met with a hypothetical client's representative to determine the project requirements, b) the sixth and seventh weeks, where the networks were optimizing the two models, and c) the ninth week, when the networks were preparing to report back to the client with their finalized designs. We excluded weeks, e.g., that were dedicated to ice breaking because they were led by the course research assistants and excluded weeks that were dedicated to preparing the individual construction schedule and 4D BIMs because opportunities for leadership were limited as the tasks were more independent in nature. By strategically selecting weeks where the tasks were either critical to the overall project outcome (i.e. the client meeting and planning weeks) or were interdependent in nature (i.e. the construction schedule being mapped to the architectural drawing to create the 4D BIM), we ensured that a range of representative interactions were captured in our analysis across the project lifecycle and that meetings contained interactions where leadership behaviors were likely to be required, and thus observed.

The virtual interactions were conducted in the CyberGRID (Cyber-enabled Global Research Infrastructure for Design) [23], a virtual workspace designed specifically to support civil engineering work interactions. In the CyberGRID, workers are able to communicate through voice and text, share and annotate documents on a team whiteboard, transfer files, and interact directly (i.e. virtually) with their models through avatars after the models have been imported into the 3D virtual space.

We chose the CyberGRID because it is novel technology that none of the study participants had experience with, although some of the participants had experience interacting in social virtual worlds. Because of the novelty of the technology, we were better able to assess whether experience with the specific technological medium of interaction leads to the emergence of leadership behaviors. Had we selected a more common platform like email or video conferencing, the role of the technology on the exhibition of leadership behaviors would not be clear because the variability in experience would have been insufficient.

4. Method

Our methodology is designed to capture both technological and interpersonal experiences of the VT members prior to their participation in the project in addition to the leadership behaviors that they exhibit over the course of the project. Before assigning students to VTs, we administered demographic surveys that asked them to indicate: 1) whether they have had any previous leadership training, 2) their total months of experience in industry, 3) their total months of experience in virtual worlds, and 4) their total months of experience working in VTs. The participants were assigned to the four VTs so as to balance these attributes evenly across the teams.

Using ELAN [24], a multi-modal annotation software that allows for annotations to be exported in tab-delimited format for quantitative analysis, we coded the recordings for evidence of leadership behaviors. Following Sacks et al. [25], our unit of analysis was the interaction, or the "conversational turn", which is typically signaled by a pause accompanied by either a change in speaker or a change in topic. This focus on the "interaction" as the analytical unit for studying leadership in VTs is also in line with Balthazard et al. [14].

Each interaction was independently identified and annotated for leadership behavior by two members of the research team and inter-annotator reliability was assessed based on comparison of annotations by a third researcher. For cases where the annotators did not agree, the research team attempted to resolve the disagreement. In cases where a mutual agreement could not be reached, the annotation(s) were excluded from the dataset. Of the 9613 interactions that were annotated, 93 were excluded, which resulted in 0.9% of the dataset deemed ambiguous.

After the annotations were completed and the survey results were returned, we utilized a multiple regression modeling process to identify patterns between the participants' prior interpersonal or technological experiences and their leadership behaviors.

5. Data and analysis

The resulting dataset constituted approximately 47 hours of interactions over four weeks by the VTs. An overview of the dataset is presented in Table 1.

Table 1. VT interaction overview

VT	Total Interactions	Total Time
1	2476	11h32m
2	1978	12h8m
3	2867	11h42m
4	2199	11h39m
TOTAL	9520	47h1m

Two types of independent and dependent variables were selected that reflect a need for synergy between the human and technological aspects of effectively leading VTs. The dependent variables were identified based on review of literature. We synthesized this literature and selected behaviors that we observed during review of the recorded interactions and that were relevant to the virtual setting in which the experiments were conducted. The name of the dependent variable, the associated literature, and our operationalization strategy are all presented in Table 2.

In most cases, we were interested in examining the quantity of interactions associated with a particular behavior following Balthazard et al. [14]. For instance, with "engagement", we counted the total number of interactions for each VT member as way to gauge their total level of interactivity during the work meetings.

Table 2. Operationalization of dependent variables and supporting literature

Interpersonal Behaviors	Source(s)	Operationalization
Rapport building	[13, 15, 16, 20, 21]	Number of interactions per network member focused on building rapport (i.e. those interactions that were not related directly to the task).
Solidarity	[15]	Ratio of total third person plural pronoun "we" to total singular first person pronoun "I" plus third person plural pronoun "we".
Engagement	[16]	Total number of interactions.
Assignments	[15, 16, 17, 18, 20]	Total number of assignments made to network members, including themselves. Assignments include interactions that clarify the task or role, delegating work, checking the status of work-in-progress, or providing feedback.
Technological Behaviors		
Troubleshooting	[20]	Number of interactions per network member during technology conflicts.
Shared Context	[6, 13]	Number of interactions that provide information about the physical setting to team members in the virtual space, e.g. cases where members leave their workstations to use the restroom or updates about what work is being enacted in the physical space when there is no activity in the virtual space.

While the "rapport building", "assignments" and "troubleshooting" variables are all straightforwardly based on interaction counts, "solidarity" and "shared context" require more explanation. Solidarity is achieved when team members feel that they are part of a whole group working cohesively. Thus, responsibility for the project outcome is accepted by all team members. Thus, to assess the level of solidarity exhibited by the VTs, we counted the total number of first person singular pronouns "I" and compared them with the number of third person plural pronouns "we" as a linguistic indicator of whether or not VT members viewed their contributions as individual or collective.

For "shared context", we counted instances where the network members provided a "spatial translation" of activity or interactions in the physical spaces that were obscured from their geographically distributed collaborators. Thus, in independent working sessions during the meetings when teams edited their models together in the physical space without any network interaction in the virtual space, shared context interactions occurred when a member would periodically update their geographically distributed teammates on their progress so the VT understood that they were still working and had not completed their task and were waiting for further assignment or instruction. This type of interaction would not be necessary in a physical setting because teams could see when their teammates where finished working. Other examples of interactions that serve to establish a shared context include informing the network when a team member was having microphone problems, or when a team member left their computer workstation to use the restroom. The descriptive statistics for the interpersonal and technological dependent variables are presented in Table 3.

Table 3. Descriptive statistics for dependent variables

	Interpersonal				Technological	
	Rapport	Solidarity	Engagement	Assignments	Troubleshooting	Context
min	2	0.039	98	1	0	18
Q1	11	0.097	187.75	3.5	3	31.75
median	14	0.128	261.5	6.5	4.5	47
Q3	23.5	0.288	340	21.5	6.25	61
max	48	0.501	1008	33	33	129
total	360	n/a	6867	246	130	1048
average	18	0.202	343.35	12.3	6.5	52.4

To explain the occurrence of the leadership behaviors associated with the dependent variables, we included four independent variables to capture the range of technological and interpersonal experiences of the network members. Three of the variables (industry experience, virtual world experience, and VT experience) were continuous and were based on the number of months of experience indicated in the survey response. The fourth variable (leadership training) was categorical and reflected whether or not the network member received leadership training at some point during their professional or academic careers. No participant received leadership training directly focused on leading VTs. Thus, we are able to assume that the training was focused solely on interpersonal behaviors, which allows us to investigate the associations between the scope of training for traditional leadership settings and whether or not this training is sufficient for effective leadership behaviors to be exhibited in the virtual setting. We asked participants to indicate their industry experience because we wanted to be able to account for their professional expertise in the context of the student projects that formed the basis of our analysis. Because a power dynamic may exist in the networks based on industry experience, and since leadership entails power differentials, we wanted to test whether those participants with more industry experience would be more likely to exhibit effective leadership behaviors.

In terms of their technological experiences, because the VTs interacted in the CyberGRID, a virtual world designed specifically to support virtual civil engineering project work, we asked participants to indicate their experience with virtual worlds in the past. Our goal here was to ascertain whether previous experience with the technological medium of interaction was more likely to result in higher exhibition of effective leadership behaviors. The descriptive statistics for the independent variables appears in Table 4.

Finally, we incorporated four interaction terms into our modeling process to account for the associations between the independent variables. Specifically, we were interested in examining whether interactions between the technological and interpersonal variables either mitigated or reinforced any effects we found between the independent and dependent variables. Thus, we explored the interaction effects of virtual world and VT experience, industry experience and leadership training, industry experience and VT experience, and leadership training and VT experience. The inclusion of these interaction terms allowed us to develop a more nuanced understanding of the relationship between the independent variables, given that many of the variables may have natural overlaps (e.g. participants who received leadership training may also have VT experience).

Table 4. Descriptive statistics for independent variables

	Interpersonal Experience		Technological Experience	
	Leadership Training (1 = received training)	Industry Experience (months)	Virtual World Experience (months)	VT Experience (months)
min	n/a	0	0	0
Q1	n/a	3	1	2.5
median	n/a	18	5.5	5
Q3	n/a	36	10	8
max	n/a	96	300	24
total	11	543	641	76
average	n/a	27.15	32.05	3.8

6. Results

Our goal with this research is to develop an understanding of the relationship between prior technological and interpersonal experience and the demonstration of effective technological and interpersonal leadership behaviors in VTs. In general, for the interpersonal dependent variables, our results indicate that prior experience working in VTs had a significant and positive effect on each of the dependent variables, with the exception of assignments (Table 5). More specifically, for every additional month of distributed team experience, rapport building interactions increased by 16.42 (m1a), the solidarity ratio increased by 18% (m2a), and total interactions increased by 129.27 (m3a). We also found that the interaction between VT experience and virtual world experience exhibited a significant and positive interaction effect for rapport building (β =24.67), solidarity (β =1%), and engagement (β = 152.38). This interaction term reinforced the main effect of VT experience on rapport building by 8.25 interactions and engagement by 23.11 interactions, but mitigated the effect of VT experience by 8% on solidarity.

Table 5. Coefficients for regression analyses predicting interpersonal leadership behaviors

	DEPENDENT VARIABLE							
	Rapport		Solidarity		Engagement		Assignments	
INDEPENDENT VARIABLE	m1	m1a	m2	m2a	m3	m3a	m4	m4a
Technology								
Virtual World Experience (months)	5.08		.02		124.31		2.42	
Distributed Team Experience (months)	18.23*	16.42**	0.13+	0.18*	142.88**	129.27**	2.41	
Interpersonal								
Leadership Training (1 = yes, 0 = no)	88.29		0.13		156.93+	177.66	4.82*	7.93***
Industry experience (months)	2.19		-0.36+	-0.12	76.33		1.95	
INTERACTION TERMS								
Virtual World Experience X Distributed Team Experience	21.21*	24.67+	0.02*	0.01*	138.42**	152.38**	3.55	
Leadership Training X Industry Experience	2.33		0.56		76.25		8.62	
Leadership Training X Distributed Team Experience	9.27		0.29		8.71		10.34	
Industry Experience X Distributed Team Experience	5.94		0.21		21.33		17.92	
Model Statistics								
intercept	8.13*	20.82+	0.31**	0.28	100.96+	111.38+	6.16***	6.29
adjusted R-squared	0.29	0.41	0.19	0.21	0.09	0.15	0.13	0.56
F	0.91	1.34	12.23	9.81	28.39	10.46	19.77	25.67
Df	8, 11	2, 17	8, 11	3, 16	8, 11	3, 16	8, 11	1, 18

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Neither VT experience as a main effect nor any of the interaction terms containing VT experience had a significant impact on the number of assignments made by the network members. However, traditional leadership training was significantly and positively associated with an increase in the number of assignments (β = 7.93).

We observed a similar pattern for the relationship between prior experience and the technological dependent variables (Table 6) in that prior VT experience was positively and significantly associated with both the troubleshooting (β = 2.77) and shared context (β = 9.63) behaviors, although significance for troubleshooting dropped below the 0.1 threshold in the reduced model (m5a). Unlike with the interpersonal dependent variables, virtual world experience contributed significantly and positively to the model for the technological dependent variables for both troubleshooting (β = 8.79) and shared context (β = 12.55). Also, as was the case with the interpersonal dependent variables, the interaction between virtual world experience and VT experience significantly contributed to the models, although for both troubleshooting (β = 8.62) and for shared context (β = 2.41), the interaction effect mitigated the main effect.

In general, our results indicate that prior VT experiences exhibits the strongest effect on each of the technological and interactional dependent variables except for assignments. Moreover, the interaction effect of previous experience in virtual worlds and VTs significantly contributed to all of the models (again, except for m4a assignments). Interestingly, the only independent variable that had a significant association with the assignment dependent variable was prior training.

Table 6. Coefficients for regression analyses predicting technological leadership behaviors

	DEPENDENT VARIABLE			
	Troubleshooting		Context	
INDEPENDENT VARIABLE	m5	m5a	m6	m6a
Technology				
Virtual World Experience (months)	3.46*	8.79**	7.21*	12.55+
Distributed Team Experience (months)	2.77**	5.92	10.45***	9.63*
Interpersonal				
Leadership Training (1 = yes, 0 = no)	0.19		1.12	
Industry experience (months)	23.34		3.98	
INTERACTION TERMS				
Virtual World Experience X Distributed Team Experience	10.23**	8.62+	6.38+	2.41+
Leadership Training X Industry Experience	1.45		4.33	
Leadership Training X Distributed Team Experience	15.23		21.28	
Industry Experience X Distributed Team Experience	3.23		4.12	
Model Statistics				
intercept	4.23**	6.51*	9.92+	10.76
adjusted R-squared	0.22	0.31	0.19	0.23
F	12.82	4.56	3.31	9.43
Df	8, 11	3, 16	8, 11	3, 16

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

7. Discussion

Our results are interesting not only for the significant relationships we observed between the independent and dependent variables, but also because of the interaction effects and the independent variables that did not significantly contribute to any of the models. In general, all of the significant coefficients were positive, which suggests that none of the prior experiences we included in our analysis had a negative impact on the exhibition of leadership behaviors. While this finding may seem straightforward, it suggests that, e.g., traditional leadership training programs are not at odds with effective leadership in VTs, but they may not sufficiently prepare workers for leadership roles in VTs. Except in the case of assignments, none of the interpersonal behaviors were affected by prior leadership training. This suggests that leadership training programs may focus too much on behaviors related to organizing work rather than the more nuanced aspects that are reflected in the other dependent variables, such as rapport building and creating a sense of solidarity.

Moreover, because there was no significant effect observed for the interaction between industry experience and leadership training, this reinforces the notion that, regardless of whether trained leaders have the opportunity to practice their leadership in authentic but traditional industrial contexts, these types of experiences may not necessarily prepare workers for leadership roles in VTs. This interpretation is in line with Purvanova and Bono [19] who demonstrate that leaders changed their behavior when shifting from face-to-face to virtual teams. Our findings suggest that the processes of rapport building [21], creating solidarity [15] and maintaining engagement [16] that have been shown to be effective leadership for VTs may require that leaders in virtual settings change their interactional patterns from those that have been taught during traditional leadership training. In other words, for example, research needs to more fully investigate whether the strategies for rapport building in face-to-face contexts transfer to virtual contexts.

Our findings suggest that VT members who have had previous experience working in a VT, regardless of the type of technological medium through which the interactions occur, are more likely to exhibit effective leadership behaviors. The effect of prior VT experience is reinforced by prior virtual world experience for all of the dependent variables except for assignments. More generally, when VT members have experience working previously in a VT *and* when they have familiarity with the specific technological medium through which the interactions occur, they are more likely to engage in effective leadership behaviors. For behaviors like troubleshooting [20] and creating a shared context [6], the link between VT experience and specific experience in the technological medium of interaction is clear as an increased familiarity with the technology and with interaction through the technology are more likely to lead to a more active role in resolving technological conflicts and in understanding the types of contextual information that need to span the virtual and physical interactional spaces. For instance, if a VT was supported solely through email, providing distributed team members with contextual information about when a worker was not at their computer would be asinine. But during the types of real-time, avatar-mediated interaction that occur in the CyberGRID, this type of information is critical since the presence of the avatar signals availability of the worker. Our results indicate that workers familiar with this relationship between avatar presence and availability are more likely to provide information that leads to the establishment of shared context.

However, it is not clear why industry experience did not significantly contribute to any of the models for either the technological or interactional behaviors. In the context of our study, these results suggest that graduate student participants who had more experience in industry were not more likely to display effective leadership behaviors, which is surprising because of the potential power differential created between those with more or less industry experience. We may expect that students with more industry experience would be able to bring these experiences to bear during the VT interactions, but again, if the industry interactions were primarily in traditional settings, then our results confirm Purvanova and Bono's [19] research who argued that different types of interactions are required for virtual versus face-to-face work settings. In our case, the participants with industry experience in traditional settings may not have modified their interactional patterns for the virtual setting, which may have resulted in no increase in effective leadership behaviors.

Also surprisingly, the interaction of industry experience and VT experience did not have an effect on leadership behaviors. Thus, participants with higher levels of leadership experience who also had higher levels of VT experience were not more likely to exhibit effective leadership behaviors, even in terms of the technological behaviors, for which we saw the strongest effect of distributed team experience as a main effect. This result is puzzling because it suggests that, e.g. a participant with no industry experience who worked on a class project in a VT is more likely to exhibit effective leadership behaviors compared to a 10-year industry veteran who engaged in VT work as part of their professional activities. One possible path toward reconciliation of these seemingly counter-intuitive scenarios that our research did not examine the relationship between the age of the participant, their range of social experiences working in VTs (e.g. in gaming and social networking communities), and their years of experience in industry. Thus, younger participants most likely have less experience in industry compared to older participants and yet more ubiquitous experience interacting and working collaboratively through technologies (like virtual worlds) as a part of their everyday lives. This type of "digital vernacular literacy" described in Iorio [26] may provide younger participants with a more nuanced understanding of how to be effective leaders, regardless of their authentic experiences in the workplace. Future research can productively explore this line of interpretation by accounting for the age of VT members in analyses of leadership potential combined with a more nuanced description of their technological experiences. We may be surprised to discover that younger workers may make better VT leaders.

Our results are conditioned by a number of assumptions that potentially limit their generalizability. First, our analysis is at times based on raw interactional counts. This approach does not account for strategic interactions in that we considered a higher number of interactions an indicator of more effective leadership behaviors. Balthazard et al. [14] attempt to explore the differences between quantity and quality of interaction, but their study examined quality in a text-based setting and was based on grammatical complexity, which may or may not be related to strategic communication. Future research can examine these relationships qualitatively to develop a better understanding of the differences between continuous versus strategic engagement. Second, our research utilizes student participants, which may not necessarily reflect the industrial population, although by working with student participants, we were afforded a much higher level of control over the experimental context. Since we were counting interactions and since the number of interactions was constrained in part by the type of task we asked the participants to perform, the ability to limit task and time on task facilitated comparability between the 4 VTs that we studied, which would not have been possible in an industrial setting. Thus, by working with student participants, we were able to conduct a more rigorous and controlled experiment, which can provide insight into organizational practices [27].

In sum, we have learned that VT experience and experience in the medium of interaction both significantly increase the likelihood of a project networker exhibiting effective virtual leadership behaviors. We have also learned which of the independent variables were not significantly correlated with an increase in effective leadership behaviors. Thus, perhaps surprisingly, prior leadership training and industry experience in traditional co-located teams were not good predictors of effective leadership in virtual teams. These findings highlight the importance of including components that directly address the challenges of leading VTs, particularly those challenges associated with the technological mediation, into leadership training programs. Moreover, our findings suggest that effective leaders in traditional work settings may not necessarily be the best candidates for leadership positions in VTs unless they have both experience working in VTs and within the technological medium of interaction. Alternatively, VTs may fruitfully adopt a shared leadership model [28] that combines: 1) the leadership strategies explored in traditional training programs and learned through experience leading teams in traditional settings, with 2) potentially untrained leaders with minimal industry experience, but who have extensive experience working in VTs, particularly in the technological medium of interaction. In this way, the technological experiences of the younger cohort of more junior members VTs can be coupled with the seasoned and traditional experiences of more senior members to provide more effective leadership through shared responsibility in VTs.

8. Conclusions

As VTs continue to become more common work structures, we need better ways of identifying and training leaders for these virtual settings. It is not sufficient to select leadership candidates for roles in VTs based solely on their successful completion of leadership training programs that have been designed with a focus on traditional work structures. Our research suggests that at a minimum, leaders of VTs should be selected in part based on their previous experience working in VTs or be provided with an opportunity to engage in distributed team work prior to receiving a leadership assignment. Moreover, given that experience with the technological medium through which the VT interactions will occur increases the effect of prior VT experience, leaders should, in part, be selected strategically based on their previous experience with the technological medium of interaction. Our work highlights the importance of revisiting traditional leadership training programs and, when appropriate, incorporating a VT component and opportunities to interact in authentic contexts with a range and combination of technological mediation tools. Our research expands our understanding of the precursors to effective leadership in VTs, which will help guide the selection and training of future leaders moving forward.

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