

Virtual and Traditional Teams: Are they Really Different? (Development and Validation of a Measure using SAS/STAT)

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ABSTRACT

The paper presents the methodology used to develop and validate an instrument that will identify the differences between virtual and traditional teams based on aspects of leadership and group dynamics. We conducted the analysis using SAS/STAT. The overall scale was determined to be reliable ($\alpha=0.89$). The reliability of the leadership sub-scale was 0.89, while that of the group dynamics measure was 0.784. One may adapt the code to perform reliability, factor and logistic analyses for other measures of natural and behavioral phenomenon.

The underlying theoretical framework and research instrument were submitted as a separate paper to the 2nd International Conference of Globally Distributed Work, in Bangalore, India.

INTRODUCTION

A virtual team is defined as "...a group of people who work interdependently with a shared purpose across time and space, time and organization boundaries using technology." (Lipnack & Stamps, 1997). They are part of the new work place. If they differ substantially from the traditional team in leadership and group dynamics, then there are potential implications for their leadership, the process of selecting team members and the management of day to day activities. The paper presents the methodology used to validate an instrument designed to measure aspects of leadership and group dynamics of virtual teams. It highlights our *preliminary* findings based on a pilot study.

METHODOLOGY

We developed the scale items in accordance using steps recommended by DeVellis (2003, p.60-87). The survey was conducted between April 1 and 13, 2006. We distributed the instrument to over 800 members of the Academy of Management's (AoM) International Management and Research Methodology Divisions, through their mailing lists and over 150 student members of a class of juniors in the College of Business of the Florida International University in a fully online course in Organization and Management. The response rate was less than 10% for the AoM membership and close to 50% for the FIU CBA juniors. We administered both surveys online-through Surveyconsole.com and WebCT, a web based instructional tool, used by many Universities. We received 114 responses.

Our analyses consisted of the following:

- (a) reliability test of the internal consistency of the instrument,
- (b) factor analysis (Principal Components Method using varimax rotation, and Maximum Likelihood) to determine if the factor score loadings are consistent across the items.
- (c) a discriminant analysis of the results to determine its ability to discriminate between groups and correctly predict the group membership of an observation. Thereafter it will be used to determine if there are differences between the groupings under study -virtual and traditional teams.
- (d) An ANOVA and regression analysis of the variables identified by the canonical correlation, with the type of team as the dependent variable.

We performed the analyses using SAS/STAT version 9, with methodology obtained from DeVellis (2003), and code obtained from Johnson & Wichern (2005) and O'Rourke, Hatcher and Stepanski (2005).

According to Hicks & Turner (1999), if the sample size exceeds 50, the Kolmogorov-Smirnov statistic is considered more appropriate than the Shapiro-Wilk test of normality (p.41). The sample was in general, normally distributed, which renders the F-test results to be meaningful. However there are some variables which were not normally distributed. Where normality conditions may not be met, it is suggested that the logistic regression method, which is non-parametric in nature be used. (Press & Wilson, 1978). As this is a pilot survey, and the true nature of the population cannot be ascertained we used both the PROC DISCRIM and PROC LOGISTIC approaches to determine if they yielded convergent results.

SAS/STAT Code for Descriptive Analysis and Normality tests:

```
OPTIONS LINESIZE=150 PAGESIZE=60 PAGENO=1;

TITLE1 'DATA ANALYSIS-VIRTUAL AND TRADITIONAL TEAMS-ARE THEY REALLY DIFFERENT?';

DATA COMBINEDAOM;

INFILE 'insert address of your input file';

INPUT  Q1 Q2  Q3 Q4      Q5      Q6      Q7      Q8      Q9      Q10 Q11 Q12 Q13 Q14 Q15
Q16 Q17  Q18  Q19      Q20      Q21      Q22      Q23      Q24      Q25  Q26 Q27      Q28
Q29 VIRTRAD Q31  Q32 Q33  Q34      TYPETEAM Group;

IF VIRTRAD=1 THEN TEAM='VIRTUAL';

ELSE TEAM='TRADITIONAL';

IF TYPETEAM=1 THEN TYPE='ACADEMIC';

IF TYPETEAM=2 THEN TYPE='STUDENT';

IF TYPETEAM=3 THEN TYPE='MANAGEMENT' ;

IF TYPETEAM=4 THEN TYPE='TECHNICAL';

IF TYPETEAM=5 THEN TYPE='OTHER';


*COMPUTING MEANS, SKEWNESS, MEDIAN AND KURTOSIS;

PROC MEANS DATA = COMBINEDAOM MEAN  MEDIAN KURTOSIS SKEWNESS;

VAR Q1--GROUP;

RUN;

*COMPUTING BASIC STATISTICAL MEASURES-MODE, STD DEVIATION, RANGE;

ODS;

PROC UNIVARIATE DATA=COMBINEDAOM;

VAR Q1--GROUP;

RUN;

PROC FREQ DATA=COMBINEDAOM;

RUN;


*UNIVARIATE NORMALITY PLOT;

TITLE2 'UNIVARIATE ANALYSIS FOR VIRTUAL AND TRADITIONAL TEAM DATA';

PROC UNIVARIATE DATA=COMBINEDAOM PLOT NORMAL;

VAR Q1--GROUP;

RUN;
```

Reliability and Validity testing

The purpose of this discussion is to evaluate the performance of the instrument - to identify possible issues related to reliability and internal consistency and potential sources of measurement error. Of special importance is its ability of discriminate between virtual and traditional teams-its real purpose.

(a) Reliability Analysis

The instrument measured two constructs, namely the member perceptions of leader behavior (Questions 1-14) and the nature of group processes and interactions (Questions 15-29). Questions 30 and 31 referred to the type of team. Questions 32-35 are demographic in nature. A reliability analysis was performed among the items of each sub-scale to determine their internal consistency. An analysis of the factor loadings suggested that item 8 (leader assigned to post or not, part of sub-scale 1 and item 35 (type of group, academic, managerial etc.) a question unrelated to either scale should be removed. Both the overall reliability coefficients and those of the subscales improved as a result of this decision. Question 23 was retained despite its border-line factor loading, as it loaded successfully during the first set of factor analyses. The reliability coefficient stood at 0.89 overall, 0.89 for the revised Sub-scale 1 and just under 0.8 (0.784) for sub-scale 2. The results of sub-scale 2 are not surprising as it measures several constructs about group dynamics, each of which it was difficult to tap in separate sub-scales because of the constraint of length of the questionnaire. The Tucker & Lewis Reliability coefficient generated by SAS PROC FACTOR for the ML Method was 0.968.

SAS/STAT Code for Reliability Analysis:

```
*COMPUTING ALPHA COEFFICIENT;  
PROC CORR DATA = COMBINEDAOM ALPHA NOMISS;  
VAR Q1--GROUP;  
RUN;
```

(b) Factor Analyses

The factor analysis indicates that the first three factors account for almost 50% of the variance of the model. The final version of the instrument will exclude Items 8 and 35. The item "Group" which was used as an administrative marker to identify the segment of the sample to which the respondent belonged (AoM vs. FIU student) did not load on any of the factors. It would therefore appear that the responses were not significant between the two groups. The item will be retained for administrative reasons. Item 6 (ease with which group leader contacted) revealed a double loading on 2 factors when items 8 and 35 were removed. It was retained as it had loaded onto a single factor during the first run. The final results suggests maximum of 9 factors. It became necessary to input the Heywood option to address the presence of communalities exceeding 1. Based on the scree plot, we selected 4 factors. The SAS PROC FACTOR revealed that 4 factors were sufficient to explain the phenomenon. The loading of the factors identified by the Principal Components Method is consistent with the constructs being measured.

SAS/STAT Code for Factor Analyses (P C and Max. Likelihood Methods):

```
*FACTOR ANALYSIS;  
PROC FACTOR DATA=COMBINEDAOM METHOD=principal NFACT=9 SCREE ROTATE=varimax S C;  
VAR Q1--Q7 Q9--Q34 GROUP;  
PROC FACTOR DATA=COMBINEDAOM METHOD=ML NFACT=9 HEYWOOD ROTATE=varimax S C;  
VAR Q1--Q7 Q9--Q34 GROUP;  
RUN;
```

Discriminant Analysis

The purpose of Discriminant Analysis is to be able to predict the class in which observations fall. The greater the accuracy of the prediction, the better the model (Johnson and Wichern, 2005). This predictive statistic known as the probability of correct classification of the Discriminant Analysis is akin to the r-square of the regression model. The prior probabilities assigned to each category were based on the sample. All of the model's variance was accounted for by the single canonical discriminant function, based on a canonical correlation of 0.898. Despite the relatively small sample size of the pilot survey, the instrument appears to have identified two distinct groups, thus displaying the

power to discriminate between virtual and traditional teams. The analysis correctly classified 98.9% of the original grouped cases, thus confirming the instrument's capacity to distinguish between, and to predict the membership of the groups.

SAS/STAT Code for Discriminant Analysis:

```
*DISCRIMINANT ANALYSIS;

TITLE2 'DISCRIMINANT ANALYSIS FOR VIRTUAL AND TRADITIONAL TEAM DATA';

DATA COMBINEDAOM;

INPUT  Q1 Q2  Q3 Q4      Q5      Q6      Q7      Q8      Q9      Q10 Q11 Q12 Q13 Q14 Q15
Q16 Q17  Q18  Q19      Q20      Q21      Q22      Q23      Q24      Q25      Q26 Q27      Q28
      Q29  VIRTRAD      Q31      Q32      Q33      Q34      TYPETEAM Group;

PROC DISCRIM DATA=COMBINEDAOM METHOD=NORMAL POOL=YES SHORT LIST CROSSVALIDATE;
CLASS VIRTRAD;
PRIORS PROP;
PROC PLOT DATA=COMBINEDAOM NOMISS;
PLOT Q1*Q10=VIRTRAD / BOX;
OPTIONS LINESIZE=120 PAGESIZE=60;
TITLE2 'OVERALL SCORES VS TRAD AND VIRTUAL TEAMS';
RUN;

*SELECTION OF VARIABLES USED TO DISCRIMINATE AMONG GROUPS;
PROC STEPDISC DATA=COMBINEDAOM METHOD=STEPWISE SLE=0.4 SLS=0.15;
*SLE(S)=SIGNIFICANCE LEVEL OF ENTRY (STAYING) INTO STEPWISE CANONICAL CORRELATION;
CLASS VIRTRAD;

VAR Q1 Q2  Q3 Q4 Q5      Q6      Q7      Q9      Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17  Q18
    Q19  Q20  Q21  Q22  Q23  Q24  Q25  Q26 Q27      Q28  Q29  Q31
    Q32  Q33  Q34  GROUP;

TITLE2 'STEPWISE DISCRIMINANT ANALYSIS OF VIRTUAL TEAMS DATA';
RUN;

PROC CANDISC DATA=COMBINEDAOM OUT=CANCOMBINEDAOM NCAN=3;
CLASS VIRTRAD;

VAR Q1 Q2  Q3 Q4 Q5      Q6      Q7      Q9      Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17  Q18
    Q19  Q20  Q21  Q22  Q23  Q24  Q25  Q26 Q27      Q28  Q29  Q31
    Q32  Q33  Q34  GROUP;

TITLE2 'CANONICAL DISCRIMINANT ANALYSIS OF VIRTUAL TEAMS DATA';
RUN;

PROC PRINT DATA=CANCOMBINEDAOM;
VAR VIRTRAD      GROUP CAN1 CAN2;
RUN;
```

FINDINGS

The final version of the instrument appears to be highly reliable, with an overall reliability coefficient of 0.885. Sub-scale 1 which measures the team members' perception of the leader has a reliability coefficient of 0.911 after the exclusion of original Item 8. Sub-scale 2, measuring the team members' perception of group dynamics has a reliability of 0.784. The factor analysis suggests that 9 factors are sufficient to explain the phenomenon under consideration. Together they account for 71.4% of the total variance observed.

The STEPDISC procedure revealed that 5 variables were most significant in explaining the differences between the two groups. They are:

- Q31-Team located in more than one country
- Q33-Length of group existence
- Q15-Opportunities for face to face meetings
- Q17-Group members' perception of their freedom to ask for help and advice.
- Group-The source of the sample-whether from the AOM or FIU groups. Both groups yielded different results.

The data was cross-tabulated by type of team (virtual/traditional) then controlled by the sample group. The CMH statistic indicates that the AOM (group 1) and FIU (group 2) groups differ in respect of the opportunities for face-to-face meetings (Q15). The AOM group's virtual teams reported a modal response of "some of the time", while the FIU group's virtual teams reported a modal response of "never". Both samples of traditional teams reported a modal frequency of face to face meetings of "most of the time". This is in keeping with the types of persons included in each sample-AOM were mostly academics-professors and doctoral students, whose research collaborations permit them to meet each other in the course of a project. The FIU students are working professionals who take classes entirely online. The CMH statistic for both groups is significant, at a 99% confidence level.

Group members of both sample groupings expressed slightly different comfort levels of feeling free to ask other members for help and advice when necessary (Q17). The AOM members' virtual teams were mostly "always" comfortable asking for help when necessary. The AOM members' traditional teams reported a modal response of "most of the time". However in almost three out of four respondents was comfortable asking for help "always" or "most of the time". Both FIU virtual and traditional teams reported a modal "always" level of comfort with asking for help when needed. However just under 70% reported being comfortable asking for help "always" or "most of the time". Students are less familiar with each other, and may be slightly less willing to ask each other for help when operating in either a virtual or traditional environment. The CMH statistic for both groups suggests that this difference between the sample groups is not significant.

The AOM sample group tends to be more distributed internationally, than the FIU student group, in keeping with the nature of academic research (Q31). The student group consisted of persons within the same country. The CMH statistic was significant at a p-value of <.0001.

Both the AOM virtual and traditional teams reported a modal length of existence of more than one year. However there was a greater frequency of short term groups among the virtual team respondents. The CMH statistic must be interpreted with caution, as it is based on a small number of observations. The FIU virtual team respondents reported a modal length of existence of their group of 6 months or less. Its traditional team respondents reported a group's length of existence of more than 6 months to more than one year, more than 80% of the time. This is in keeping with the types of persons included in each sample-AOM were mostly academics-whose research collaborations in the virtual environment may be temporary in nature. The CMH statistic is significant at a p-value of <.0001. The output of the cross-tabulations and CMH significance tests are included in a supplementary data analysis file to conserve space. The 4 independent variables identified by the canonical correlation accounted for 66.81% of the variation in the model, with a p-value of <.0001. The variables had close to zero correlation between them.

SAS/STAT Code for Cross-tabulations and Regression Analysis/ANOVA:

```
*CROSS-TABULATIONS FOR VARIABLES FOUND TO BE SIGNIFICANT;
PROC FREQ DATA=COMBINEDAOM ORDER=DATA;
TABLES Q15*VIRTRAD / CHISQ;
PROC FREQ DATA=COMBINEDAOM ORDER=DATA;
TABLES Q17*VIRTRAD / CHISQ;
PROC FREQ DATA=COMBINEDAOM ORDER=DATA;
TABLES Q31*VIRTRAD / CHISQ;
PROC FREQ DATA=COMBINEDAOM ORDER=DATA;
TABLES Q33*VIRTRAD / CHISQ;
PROC FREQ DATA=COMBINEDAOM ORDER=DATA;
TABLES GROUP*Q15*VIRTRAD / CHISQ CMH;
PROC FREQ DATA=COMBINEDAOM ORDER=DATA;
TABLES GROUP*Q17*VIRTRAD / CHISQ CMH;
PROC FREQ DATA=COMBINEDAOM ORDER=DATA;
TABLES GROUP*Q31*VIRTRAD / CHISQ CMH;
PROC FREQ DATA=COMBINEDAOM ORDER=DATA;
TABLES GROUP*Q33*VIRTRAD / CHISQ CMH;
TITLE2 'CROSSTABULATION ANALYSIS OF VIRTUAL TEAMS DATA';
RUN;
*REGRESSION ANALYSIS;
PROC REG DATA=COMBINEDAOM;
MODEL VIRTRAD=Q15 Q17 Q31 Q33 /p r i covb dw ;
TITLE2 'REGRESSION ANALYSIS/ANOVA OF VIRTUAL TEAMS DATA';
RUN;
```

Logistic Regression Analysis

The PROC LOGISTIC procedure yielded similar results to that of PROC DISCRIM. The significant determinants of the differences between virtual and traditional teams are:

Q34-Type of group (Academic, Management, Student etc.)

Q15-Opportunities for face to face meetings

Q17-Group members' perception of their freedom to ask for help and advice.

The inclusion of Q34 is in keeping with the results of the cross-tabulated results based on the two samples. The FIU group comprised mostly professionals. The AoM groups consisted of academics.

SAS/STAT Code for Logistic Analysis:

```
*CREATING DUMMY VARIABLES FOR USE IN LOGISTIC REGRESSION;  
DATA COMBINEDAOM; SET COMBINEDAOM;  
IF VIRTRAD=1 THEN NVIRTRAD=1; ELSE NVIRTRAD=0;  
*CODE TO FIT THE LOG REGRESSION MODEL (ESTABLISH DECISION RULES);  
PROC LOGISTIC DATA=COMBINEDAOM;  
MODEL NVIRTRAD = Q1 Q2 Q5 Q6 Q7 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18  
Q19 Q20 Q22 Q23 Q24 Q25 Q27 Q31 Q33 Q34/SELECTION=BACKWARD;  
TITLE2 'LOGISTIC REGRESSION ANALYSIS OF VIRTUAL TEAMS DATA';  
RUN;
```

In both instances, the model yielded a negative relationship between the dependent variable (VIRTRAD/NVIRTRAD) and Q17 (group members' perception of their freedom to ask for help and advice). It appears that this becomes an issue in virtual teams.

Efficiency of the Process

The process can be considered efficient for the following reasons:

1. The code was developed in modules, each of which may be executed separately.
2. Each may also be extracted for subsequent use in other analyses.
3. The logic is similar to the flowcharted processes of SAS Enterprise Guide. The code may be easily converted for use under SAS Enterprise Guide.
4. With the exception of the Cross-tabulations and (Logistic) Regression Analysis, the code may be executed in a single step, once the factor/reliability analyses are finalized.

CONCLUSION

Virtual and traditional teams are largely similar in the manner of group perceptions of their leader and much of their leader-member interactions. Both methods yielded similar results. The key differences appear to lie in the following areas:

- (i) the nature of the composition of the team-students, professionals or academic researchers,
- (ii) Opportunities for face to face meetings
- (iii) Group members' perception of their freedom to ask for help and advice

The type of member comprising the group (student, academic, corporate employees) has an impact on the characteristics of the group. It appears to affect the frequency of group interactions. The length of group existence affects the nature of interactions between the members. We suggest that this may be related to the extent of trust built among the members.

The approach and code may be used to validate instruments measuring any natural and behavioral phenomenon, especially those requiring the comparison of two or more groups.

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ACKNOWLEDGMENTS (USE THE SESUG HEADING STYLE.)

he researchers acknowledge the kind contribution of Peter Eberhardt of the Fernwood Consulting Group Inc., and Dr. Patricia Cerrito of the University of Louisville.

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APPENDIX

TABLE 1

Reliability Statistics (all items)

Cronbach's Alpha	N of Items
.895	34

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between People	704.348	95	7.414		
Within People	2336.391	33	70.800	90.919	.000
Between Items	2441.256	3135	.779		
Residual(a)	4777.647	3168	1.508		
Total	5481.995	3263	1.680		

Grand Mean = 3.25

a. Tukey's test for nonadditivity is undefined for dichotomous data.

TABLE 2

Factor	Question (s)	Related construct
1	1-2, 5-7, 10-14	Member perception of leader actions to maintain group cohesiveness.
2	15, 30-31, 33-34	Characteristics of team (virtual vs. traditional), expected and actual lifespan.
3	16, 18-20, 22-24	Enthusiasm, supportiveness and other results of group interactions that impact on productivity.
4	17, 25, 27	Comfort level with other team members.

Results of Factor Analyses-Principal Components Method

Table 3(a) Significance Tests Based on 97 Observations-Principal Components Method

Test	DF	Pr >	
		Chi-Square	ChiSq
H0: No common factors	561	1928.3795	<.0001
HA: At least one common factor			
H0: 9 Factors are sufficient	291	334.0328	0.0418
HA: More factors are needed			

Table 3(b) Significance Tests Based on 97 Observations- Maximum Likelihood Method
(with Heywood Option selected)

Test	DF	Pr >	
		Chi-Square	ChiSq
H0: No common factors	561	1928.3795	<0.0001
HA: At least one common factor			
H0: 9 Factors are sufficient	291	334.0328	0.0418
HA: More factors are needed			

Chi-Square without Bartlett's Correction	411.99767
Akaike's Information Criterion	-170.00233
Schwarz's Bayesian Criterion	-919.24323
Tucker and Lewis's Reliability Coefficient	0.93933

Instrument Capacity for Discrimination among Groups

Table 4(a) Class Level Information

Variable				Prior	
VIRTRAD	Name	Frequency	Weight	Proportion	Probability
1	_1	71	71.0000	0.739583	0.739583
2	_2	25	25.0000	0.260417	0.260417

Table 4(b) Resubstitution- Number of Observations and Percent Classified into VIRTRAD

From VIRTRAD	1	2	Total
1	71	0	71
	100.00	0.00	100.00
2	1	24	25
	4.00	96.00	100.00
Total	72	24	96
	75.00	25.00	100.00
Priors	0.73958	0.26042	

Error Count Estimates for VIRTRAD

	1	2	Total
Rate	0.0000	0.0400	0.0104
Priors	0.7396	0.2604	

Table 4(c) Crossvalidation- Number of Observations and Percent Classified into VIRTRAD

From VIRTRAD	1	2	Total
1	65	6	71
	91.55	8.45	100.00
2	5	20	25
	20.00	80.00	100.00
Total	70	26	96
	72.92	27.08	100.00
Priors	0.73958	0.26042	

Error Count Estimates for VIRTRAD

	1	2	Total
Rate	0.0845	0.2000	0.1146
Priors	0.7396	0.2604	

Table 5(a) The STEPDISC Procedure

Class Level Information					
Variable					
VIRTRAD	Name	Frequency	Weight	Proportion	
1	_1	71	71.0000	0.731959	
2	_2	26	26.0000	0.268041	

Table 6 ANOVA for Variables Identified in the Canonical Correlation

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	13.02339	3.25585	49.81	<.0001
Error	93	6.07865	0.06536		
Corrected Total	97	19.10204			
Root MSE					
		0.25566	R-Square	0.6818	
Dependent Mean					
		1.26531	Adj R-Sq	0.6681	
Coeff Var					
		20.20535			

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.42464	0.13752	3.09	0.0027
Q15	1	0.07743	0.02146	3.61	0.0005
Q17	1	-0.05998	0.02798	-2.14	0.0347
Q31	1	0.30474	0.03842	7.93	<.0001
Q33	1	0.16526	0.03306	5.00	<.0001

Table 7 Analysis of Maximum Likelihood Estimates (LOGISTIC Regression)

Parameter	DF	Standard Estimate	Wald Error	Chi-Square	Pr > ChiSq
Intercept	1	-4.6360	1.7403	7.0966	0.0077
Q15	1	1.2436	0.3562	12.1913	0.0005
Q17	1	-0.8462	0.3955	4.5787	0.0324
Q34	1	1.4659	0.3795	14.9179	0.0001