Gender Differences in a Text-Based Virtual Environment

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Abstract

Research which addresses gender issues in a virtual environment is an emerging area. In the area of small group research, it has been found that perceived gender differences will enter into group’s interactions and impact the group’s processes and outcomes. A framework for evaluating gender differences in a text-based virtual environment was formed and underpinned by Essentialism theory, Similarity-attraction paradigm and Individual Difference theory, and further validated by an experiment which was engaged in a text-based discussion system “Blackboard”. The results revealed that females perceived higher extent of relationship building, commitment and satisfaction than males but perceived no significant differences in communication, trust, collaboration and performance. It was also found that there was difference between males and females in their behavioral patterns. Females presented more adaptive and enjoyable attitude in working in a virtual environment than males because of the equality and fairness created by CMC (Computer-Mediated Communication). Females also regarded CMC as a tool to reduce conflict. The managerial application is provided for managers to retrieve a better performance while they are managing virtual teams.

Keywords: Gender difference, Virtual environment, SEM, CMC, virtual teams
1. Introduction

CMC (Computer-Mediated Communication) has been changing the way that people and organizations work and communicate, which leads to a trend “virtual teams” where increasingly teams do not work face-to-face (FTF) but interact via CMC [1][12]. A virtual team is a temporary gathering of individuals who are connected through information technologies working across time and space to finish a goal [15]. Unlike research on traditional face-to-face teams where gender issues has been identified as a crucial component [34], little research has been done to determine the role of gender in virtual teams and form intact models to present the disparity across genders. Thus, the purpose of this study is to address the gender issues in virtual teams by identifying the key factors from the literature to build a framework and engaging in an experiment and survey to validate it. Interview was conducted to explore further in depth regarding to how males and females felt while they were working in a virtual environment.

This study firstly introduces the literature relates to gender differences in general, work groups and virtual environment. Then through an extensive discussion of constructors, an intact framework and hypotheses are built. Followed by the introduction of the experiment and survey, the hypotheses and multi-group SEM models are examined. The discussion section explains the findings and the managerial applications are presented at the end.

2. Gender differences

2.1 General gender difference

The existence of biological difference between genders has led to a tendency to assume that other observed differences between males and females are due to biological determinates [39]. Essentialism theory [64] attributed observed differences in males and females’ behaviors to what are believed to be inherent, fixed, group-level differences that are based upon bio-psychological characteristics. An inference that can be drawn from an essentialist approach to gender in a virtual environment is that males and females should be treated differently. For example, Venkatesh and Morris [63](p. 131) recommended that trainers adopt different approaches toward males and females and that marketers design different marketing campaigns for both genders. Their study also implied the importance of policies for addressing the gender imbalance and the equality issues across genders.

Research has found that females agreed more often, asked more questions, challenged others less often and qualified other's arguments less often than males [43]. Gender has been correlated with prestige and accompanied by differing expectations for males and females’ social power [50]. Males and females perceived differences in the amounts of respect, influence and prominence, which may affect their behaviors and attitudes in groups. O’Farrell and Harlan [47] reported that females who were working in a male-dominated environment were subject to harassment. Such as female police officers experienced disadvantage in their jobs while they were working in a male-dominated environment [48]. Furthermore, males are more sensitive than females to be in the minority because males have historically been in the majority and enjoyed higher position in a group. Thus, males may perceive being in the minority as a power loss but females with more experience located in lower position or as
numerical minorities do not [60]. These studies presented the substantial heterology between males and females.

2.2 Gender in group outcomes

It is also found that the asymmetry of team composition in gender affects group outcomes. Males respond more negatively, being absent more often, behave less committed than did females when they are in the numerical minority in a group [31] [60]. Males also show the tendency of sexism when they are in male-dominated groups while females maintain more egalitarianism regardless of the sex composition.

The Similarity-attraction paradigm [7] suggests that people are attracted to and prefer to spend time with partners who have similar attitudes. Drawing on this logic, people who are more similar to a group are more likely to present higher commitment and lower turnover [70][23]. Males appear to be more sensitive to being different than females, which implies males respond with more negative attitudes than do females when group heterogeneity increases [69]. In summary, males are attracted to work in groups with more males while females are attracted to work in groups with more females [10].

2.3 Gender in a virtual environment

The Social Construction of Reality [5] argued that all knowledge is derived from and maintained by social interactions. When people interact, they do so with the understanding that their respective perceptions of reality are related, and as they act upon this understanding their common knowledge of reality becomes reinforced. Since this common sense knowledge is negotiated by people, human typifications, significations and institutions come to be presented as part of an objective reality. It is in this sense that it can be said that reality is socially constructed. This theory’s implication toward this study is that group outcome comes from the interactions of virtual team members, which infers the virtual team members need to agree certain conventional rules or norm being a team to accomplish the tasks.

Virtual team members work based on CMC such as e-mail, discussion board, Blog, video and voice conference, as they often communicate asynchronously in accomplishing their jobs. This type of collaboration enables them to be uninhibited in the obstacles of distance and different time zones. However, recent studies have highlighted a rising phenomenon: females prefer working in a virtual environment and have higher extent of satisfaction than males [37][42]. For example, Lind [37] found that females showed higher tendency of greater task analyzability, less task variety and greater information equivocality in email usage. Another study by Gefen and Straub [13] proved that females perceived higher social presence and usefulness for CMC technology. However, the traditional communication theories such Media Richness theory [11], Social Identity and Deindividuation (SIDE) model [35], Social Information Processing perspective [66] are incapable of providing the answers toward this. The researcher intends to provide the answer for this mystery and further provide a better design and management of virtual teams.

2.4 Forming the framework

2.4.1 Theoretical aspect

It can be argued that Essentialism theory, Similarity-attraction paradigm and The
Social Construction of Reality view gender in a virtual environment as fixed with the difference being the basis for “fixing” gender. What these theories have in common is the assumption that females working in a virtual environment, as a group, are different from, males, as a group, either for sociological, biological or psychological reasons. This suggests some gaps in the theoretical options available for analyzing gender in a virtual environment. This gap can be addressed by the Individual Difference theory [59] which is situated between Essentialism theory and The Social Construction of Reality. This theory focuses on the similarities among males and females as individuals, and the variation among members of each gender group with respect to a virtual environment and inclination to participate in tasks. It looks to socio-cultural interpretation of a virtual environment and power relations to explain the level of participation by virtual team members. According to this theory, knowledge in a virtual environment is socio-culturally constructed at the individual level and group level.

Based on the Individual Difference theory, the researcher believes that virtual teams accomplish tasks by not only individual capacity but also members’ interactions to form the knowledge to solve the issues. Figure 1 aggregates these theories introduced above to form the basis of this study. Essentialism theory is applied to individual level, which means males and females have the innate diversity. Similarity-attraction paradigm explains the attraction between members with similar characteristics to lead the interactions between virtual team members. After the interactions between virtual team members, the group knowledge is derived and used to solve the tasks, which can be explained by social construction theory. The whole process can be included by Individual Difference theory. Figure 1 gives a big picture of how virtual team members interact to generate knowledge in order to solve the problem, which directs the design of the experiment in section 3.

Figure 1 The theoretical basis of this study
2.4.2. Forming Framework

To form a feasible framework to evaluate the gender issues in a virtual environment, the researcher followed the “IMO” (Input-Mediator-Output) structures by Ilgen et al [21] instead of the classic IPO (Input-Process-Output) model. Great deals of factors have been explored as impacting on virtual teams. These factors intervene and transmit the influence from input section to output section instead of processing. Thus, replacing “Process” by “Mediator” is satisfactory to the operational definition. Due to the indispensability of conveying information to each other for virtual team members, communication is regarded as the input for the framework. Output section includes the most frequently used indices: performance and satisfaction. Satisfaction focuses on the degree of members perceive the fulfilment of the process while performance is related to the perception of the achievement of their outcomes.

As to “Mediator” section, literature on virtual teams falls into two categories as task dimension and social dimension. Social dimension has been found to be ignored in the past decades [12]. To avoid the imbalance and prejudice of comparing the gender difference in virtual teams, both dimensions were incorporated. Task dimension factors which have been widely researched include factors such as collaboration [29] and commitment [52][19]. Social dimension factors include relationship building [55][49], and trust [55][45].

Two paths called social and task dimension path are depicted as Figure 2:

![Figure 2 Framework of this study](image)

Social dimension path: Communication ➔ trust ➔ relationship building ➔ performance and satisfaction

Deriving principles from the social information processing (SIP) theory [65], trust is identified to link tightly with communication. A person who perceives higher extent of trust would view them as more closely associated with one another in sharing common objectives, information and success [10], which fosters the development of social relationship [33]. Relationship building can strengthen feelings of inclusiveness or a sense of belonging to teams and further improve the performance and satisfaction of virtual teams [52].

Task dimension path: Communication ➔ Collaboration ➔ Commitment ➔ performance and satisfaction
Due to the absence of FTF communication, misunderstandings occur easily and hinder the coordination of virtual teams, which means poor communication leads poor collaboration [28]. Collaboration is a key ingredient in forming and maintaining a collaborative atmosphere and facilitates supportive behaviors, reducing detrimental conflicts, helping the successful development of solutions [53] and further nourishes the commitment, which means that team members would accomplish what they have promised. Commitment has been found to affect performance and satisfaction [52].

Satisfaction is regarded as the extent to which the group members fulfill their goals while performance is the extent to which the group members perceive the productivity. The model of motivation by Porter and Lawler [51] promotes the assumption that effective performance leads to higher satisfaction. If virtual team members sense a higher performance, the degree of satisfaction would also be higher [46].

2.4.3 Hypotheses Establishment

The factors are discussed below to establish the hypotheses.

Communication (H1)

It has been found that females have the tendency to work harder to maintain communication in a working group [43]. A common communication tendency different from males and females is that males communicate to establish social standing, control conversation and self-promoting more than females while females communicate to create rapport and affinity more than males [32][58]. Females’ communication tends to be tentative, less forceful and more social-orientated than males, and they tend to create a group where all members participate [68]. Males and females speak differently with different social objectives. This rift causes that they can communicate with the same gender with less misunderstanding but more misinterpretation while they communicate with opposite gender [58].

Research has also shown that the gender differences in CMC. Gefen and Straub [13] found that females perceived higher social presence and more useful than males in email usage. Yates’ [71] research revealed that males posted more often and longer message than females in a CMC environment. He also reported that males posted more social messages than females though females produced more “interaction” messages that referred to others in the group. Gefen and Ridings [14] found that females showed higher extent of giving and receiving social supports and had a more favorable assessment of the capability of others in an online writing environment. Through these studies, it can be concluded that males tend to retrieve more information through CMC while females interact with other members more in groups, which implies that males tend to be task-orientated while females tend to be social-orientated while they are working in virtual teams.

From the discussion, hypothesis can be proposed as below:

\textit{H1: There is a significant gender difference in the perception of communication.}
Trust (H2)
Researchers have made a significant effort to explore the trust in virtual teams [72][65]. However, the effects of gender issues on trust in virtual teams have not received a popular attention. Sun et al. [57] reported that female pairs perceived higher extent of trust than male pairs when gender information was explicitly provided before the virtual team project started, while there was no significant difference between the two genders on the trust perception when gender information was not unveiled before the project started. This study suggested that providing sufficient gender information through CMC (e.g., video conference, Instant Messenger or text-based discussion) may enable females to retrieve higher extent of trust and further improve the group performance. Another finding of this study is that both genders perceived higher level of trust in the brainstorming task than in the negotiation task, which may attribute to the competitive nature of the negotiation task.

The hypothesis 2 is proposed below:

\[H2: \text{There is a significant gender difference in the perception of trust}\]

Relationship Building and Collaboration (H3, H4)
While we observe the gender difference in computer games, females are more interested in cooperating with others instead of competing. They like complex social interaction and are fascinated by relationships between characters and other game players. By contrast, males prefer highly competitive games which focus on scoring, fighting or challenging them mentally [16]. It was found that females agreed more often, asked more questions, challenged others less often and qualified other's arguments less often than males [43]. It can be inferred that gender differences in a non face-to-face environment are the result of socialized and coordinated differences and should therefore occur also within the written communication of virtual teams.

The hypothesis 3 and 4 are proposed below:

\[H3: \text{There is a significant gender difference in the perception of relationship building.}\]

\[H4: \text{There is a significant gender difference in the perception of collaboration.}\]

Commitment (H5)
According to the Similarity attraction theory, researchers have reported similarity in values is associated with increased attraction and liking [17][61], suggesting that groups with more members of one sex may be more attractive to members of that sex, and resulting in higher commitment. It can be inferred that males and females may present different extent of commitment in a virtual team.

Thus, hypothesis can be proposed as below:

\[H5: \text{There is a significant gender difference in the perception of commitment}\]

Performance and Satisfaction (H6, H7)
Lind [36] studied the gender impact on 29 virtual teams and found that females perceived higher satisfaction and enjoyed more virtual team work than males. This study also suggested that the group experience allowed females to overcome the unspoken social cues of face-to-face communication. It also implies that virtual team technology enables to equalize the effect on the performance and satisfaction for females.

Thus, hypothesis 6 and 7 can be proposed as below:

\[H6: \text{There is a significant gender difference in the perception of performance}\]

\[H7: \text{There is a significant gender difference in the perception of satisfaction}\]
Gender differences in the behavioral pattern (H8)

The existing theories (e.g., Essentialism theory) and empirical studies (e.g., [67]) concerning gender disparity in a CMC environment have evidently addressed variations in terms of their behaviors. For example, Females tend to demonstrate a more socio-emotional behavior [67], non-aggressive strategies, less confidence in patterns of interaction [4][2] and more positive attitude towards teamwork and collaboration [42]. It is suggested that socialization causes the root of these different behaviors instead of biological sex [18].

Therefore, the researcher speculates that gender may cause different patterns of males and females’ behaviors, which brings about different path coefficients of Figure 2 across genders. The hypothesis 8 is proposed:

H8: There is a significant gender difference in the behavioral pattern.

3. Research Methodology

Based on Figure 1, group knowledge and outcomes originate from the interaction between virtual team members. An experiment was designed, giving participants a task to work in groups and hand in reports at the end of the task. In total, 310 undergraduate and postgraduate students (male: 142; female: 168) in business faculty were recruited to take part in this experiment. They were all familiar with basic computer technology such as the Internet, word processing, and Blackboard which is a Networked Learning Environment Courseware by Blackboard, Inc. (http://www.blackboard.com) that supports course cartridges, discussion board and community. Students were firstly categorized by their genders and then were chosen randomly from their gender groups to form a virtual team with two males and two females. The reasons to mix up the genders are twofold: engaging in a natural environment and providing a better statistical power. Most studies engaged in and compared threefold setting: two pure gender groups and one mix-up gender group. However, it causes two main problems: firstly the working groups in the realistic world are not pure gendered. Secondly dividing the limited subjects may deteriorate the statistical power due to the smaller sample size. Also, if the pure gender groups are set, these two kinds of groups may develop different patterns. The results may be retrieved from the difference between gender groups instead of individual disparity from males and females, and it would lead the difficulty to compare the different perception caused by gender.

As a result, 77 virtual teams with four members were formed and efforts made to ensure that none of the team members knew other team members before their teams were built. 64 teams comprised half males and half females, and 13 teams comprised one male and three females (one of them had 4 females) were established. Blackboard, a text-based tool was chosen as the platform to communicate between participants because the simplification of the text-based mode would not interfere with members’ communication and produce unexpected situation to distort the results. Such as mixing up text mode, voice and video could lead the multi-channel communication and confuse the findings.

A judgment task which is a highly interdependent task and can be used to promote the participants’ conversation and interaction [41] was applied in this experiment. A fictitious and controversial case was given as the task, which is about a
famous BBQ restaurant facing some serious problems and challenges such as the lack of the ability to manage customer orders, poor stock management, and the difficulties in managing human resource issues. Each team was asked to find solutions for the restaurant with a limited time and budget. In addition, team members could only communicate with others via the given communication platform, Blackboard, and any other communication methods, such as email, voice and web camera, were prohibited. Participants were only allowed to communicate through the discussion board (text mode) provided by Blackboard to complete the assigned task. The researchers observed the discussion threads in the discussion board and these discourses were analyzed to ensure the task was completed through the given communication platform. At the end of this task, each team had to hand in a report. The top three teams would be rewarded cash vouchers to promote the motivation.

Following the completion of the task, all students were asked to fill out questionnaires. Questionnaires were chosen because it allows the researchers to gather the information from participants systematically to understand and predict some aspects of the behavior of the population of interest. Participants were asked to use a 7-point Likert scale in answering the questions related to the developed framework. The questionnaire was derived from a wide range of active virtual teams corroborate past CMC studies and was composed of seven parts related to the seven variables identified in the framework: communication, relationship building, commitment, collaboration, trust, performance and satisfaction. All of the measurement items in the questionnaire were taken from previous studies and shown in Appendix 1. Two follow-up email and phone calls were carried out to increase the response rate. In total, 302 questionnaires were returned but one was discarded due to the incompletion. As a result, 301 valid questionnaires were collected which gave the return rate of 97%.

12 semi-structured interviews (half males and females) were conducted simultaneously. All members in the three teams located in the categories of better, moderate and poor performance were asked to participate in the interview. The interviewees were asked about their perception of working in a virtual team and working with their counterparts. Partial results are introduced in the discussion section to elaborate the findings.

4. Data analysis

In order to test the hypotheses 1~7, t-test was applied to analyze the different perceptions across genders to retrieve the outline of gender differences in a virtual environment. For examining the hypothesis 8, a multi-group SEM (Structured Equation Model) was applied to form the models of males and females individually, which presented the different behavioral patterns. According to the models derived from SEM, the direct and indirect effects of communication, collaboration, trust, commitment and relationship building on satisfaction and performance were calculated to present the influences of factors toward the satisfaction and performance and were shown in Appendix 2.

The traditional method applied to reveal factorial relationships is to adopt multiple regression analysis to create a path diagram. However, this may cause error inflation and, it is unrealistic to assume that there is no measurement error for observation variables. Furthermore, multiple regression analysis has little power to manipulate implicit behaviors and mental characteristics which are regarded as latent
variables. SEM is composed of two parts: structural model and measurement model [25]. The former shows the relationships between latent variables while the latter presents the relationships between latent variables and measurement indices. SEM is a technique that integrates measurement and statistical analysis by conceptualizing unobservable concepts as latent variables and formalizing observed results as measurement models. It allows the ‘concretizing’ of unobservable variables. Measurement models not only consider the error caused by measurement items’ interactions but also take the relationships between measurement items and latent variables into account [22]. Furthermore, the property of emphasizing multiple criteria to examine the goodness of model fit instead of a single index makes SEM superior and suitable to apply to test the model in this study. There are many commercial statistical packages, such as Lisrel, EQS, AMOS, CALIS, and MPLUS, but LISREL has been the most frequently used by scholars due to its solid theoretical bases and detailed outputs. Thus, LISREL is selected as the tool performing SEM in this study.

For the purpose of comparing the gender impact, ascertaining the proposed framework is capable of applying on both genders is required. Thus a cross validation of the structural and measurement model was conducted. If the structural model is identical across genders, it means that male and female groups have the same structural model while if the measurement model is identical across genders, both groups have the same measurement model. The cross validation was introduced in section 4.2. With the result of cross validation, SEM can be applied to build the models for both genders.

Considering the sample size and population, this study combined the suggestions by Bagozzi and Youjae [3] and Jöreskog and Sörbom [26], and chose five figures to evaluate the goodness of model fit: $X^2$/degree of freedom, RMSEA (Root Mean Square Error of Approximation), GFI (Goodness of fit index), AGFI (Adjusted GFI), CFI (Comparative-fit index). Table 1 shows the criteria:

<table>
<thead>
<tr>
<th>Index</th>
<th>Purpose</th>
<th>Range</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X^2$/df</td>
<td>Consider the degree of freedom</td>
<td>&lt;3</td>
<td></td>
</tr>
<tr>
<td>RMSEA</td>
<td>Compare the difference between hypothesized model and saturated model</td>
<td>0-1</td>
<td>&lt;0.06 good fit &lt;0.08 acceptable</td>
</tr>
<tr>
<td>GFI</td>
<td>The proportion of the explanation of observed data by hypothesized model</td>
<td>0-1</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>AGFI</td>
<td>Consider the degree of freedom</td>
<td>0-1</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>CFI</td>
<td>The no-central difference between hypothesized model and independent model</td>
<td>0-1</td>
<td>&gt;0.95</td>
</tr>
</tbody>
</table>

The value of Chi-square is influenced by sample size as a large sample size always leads to model rejection [22]. Thus, Bagozzi and Youjae [3] suggested using the value of Chi-square/degree of freedom to test the model fit and an appropriate value of below 3 [9] if the p-value of $X^2$ is insignificant. McDonald and Ho [40] suggested that a RMSEA value less than 0.06 corresponds to a “good” fit while a RMSEA less than 0.08 corresponds to an “acceptable” fit. Hu and Bentler [20] claimed that GFI and AGFI would be acceptable if the value is greater than 0.9. In addition, there would be a relatively good fit between the hypothesized model and the observed data if CFI value is greater than 0.95 [20].
4.1 t-test of hypotheses 1~7
The t-test results which examine hypotheses 1~7 are shown in Table 2.

Table 2 Hypotheses tested results (H1~H7)

<table>
<thead>
<tr>
<th>Factors</th>
<th>Gender</th>
<th>N</th>
<th>Mean(Std.)</th>
<th>t-test significance for gender</th>
<th>Hypotheses tested result (H1~H7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>male</td>
<td>138</td>
<td>4.55(0.79)</td>
<td>Not significant</td>
<td>H1: not support</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>163</td>
<td>4.41(0.69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust</td>
<td>male</td>
<td>138</td>
<td>5.01(1.45)</td>
<td>Not significant</td>
<td>H2: not support</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>163</td>
<td>5.10(1.38)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship building</td>
<td>male</td>
<td>138</td>
<td>4.20(1.11)</td>
<td>Significant (p&lt;0.10)</td>
<td>H3: support</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>163</td>
<td>4.47(1.16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td>male</td>
<td>138</td>
<td>5.00(0.98)</td>
<td>Not significant</td>
<td>H4: not support</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>163</td>
<td>5.16(1.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commitment</td>
<td>male</td>
<td>138</td>
<td>5.92(1.10)</td>
<td>Significant (p&lt;0.10)</td>
<td>H5: support</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>163</td>
<td>6.16(1.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>male</td>
<td>138</td>
<td>5.52(0.82)</td>
<td>Not significant</td>
<td>H6: not support</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>163</td>
<td>5.31(1.10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>male</td>
<td>138</td>
<td>4.68(1.61)</td>
<td>Significant (p&lt;0.10)</td>
<td>H7: support</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>163</td>
<td>5.07(1.52)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From Table 2, it can be seen that females perceived higher extent of relationship building, commitment and satisfaction. There were no significant differences in the perception of communication, trust, collaboration and performance across genders.

4.2 SEM analysis for hypothesis 8
For testing hypothesis 8, there is a need to build the path diagrams for both genders. However, a cross validation of the structural and measurement model should be conducted in the first place. H0 is hypothesized as “Both genders have equal structural or measurement models” and H1 is hypothesized as “Both genders have unequal structural or measurement models”. Followed the suggestion by Jöreskog and Sörbom [26], Chi-square (X²), Degree of Freedom (DF) and P-value of the equal, unequal and difference for structural and measurement model are calculated and presented in Table 3.

Table 3 Cross validation of the structural and measurement model

<table>
<thead>
<tr>
<th>Structural model validation</th>
<th>Hypothesis</th>
<th>X²</th>
<th>DF</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal(H0)</td>
<td>810.23</td>
<td>181</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>Unequal(H1)</td>
<td>780.85</td>
<td>161</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>Difference</td>
<td><strong>29.38</strong></td>
<td><strong>20</strong></td>
<td></td>
<td><strong>0.08</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measurement model validation</th>
<th>Hypothesis</th>
<th>X²</th>
<th>DF</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal(H0)</td>
<td>820.03</td>
<td>223</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Unequal(H1)</td>
<td>720.19</td>
<td>210</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Difference</td>
<td><strong>99.84</strong></td>
<td><strong>13</strong></td>
<td></td>
<td><strong>0.0</strong></td>
</tr>
</tbody>
</table>
From Table 3, it can be seen that the significant P-value of structural model (0.08) suggests that there is sufficient evidence to support that both genders have equal structural models while the small P-value of measurement model (0.0) implies that there is no strong evidence to support that both genders have equal measurement models. To conclude it, both genders have the same structural models but different measurement models.

Then, a multi-group SEM was applied to build the models for both genders. The settings with the same structure models and different measurement models were arranged to reflect the results of cross validation and the multi-group models were built to present the path coefficients which are shown in Figure 3 and 4 below.

**Figure 3 Female model**

X^2=330.47, df=184, X^2/df=1.79, p-value=0.00, RMSEA=0.076, CFI=0.95, IFI=0.95, GFI=0.85, AGFI=0.83

**Figure 4 Male model**

From Figure 3 and 4, it can be seen that:
1. Model fit: overall the multi-group models present a good model fit: X^2/df <3 (1.79), RMSEA <0.08 shows an acceptable level (0.076), CFI and IFI >0.9 (both 0.95), only GFI and AGFI are slightly lower than the criterion 0.9 (GFI=0.85, AGFI=0.83).
2. Path coefficients analysis: The insignificant paths in the female model are two: commitment to performance and satisfaction. The only insignificant path in the male model is commitment to performance. Other path coefficients in both models are significant. Thus, the difference between the two models is the insignificant path coefficient (commitment to performance) in the female model.

The direct and indirect effects of communication, collaboration, trust, commitment and relationship building on satisfaction and performance were derived from the calculation of models’ path coefficients and presented in Appendix 1.

By observing the Figure 3, 4 and Appendix 1, the path coefficients and the
factors’ effects on performance and satisfaction are explained below and the results are used to test the hypothesis 8 at the end.

**Communication**
Comparing models’ path coefficients from communication to trust, and communication to collaboration, both genders have similar positive strengths. This implies that communication has a positive effect on trust and collaboration in both genders. By observing Appendix 1, communication has weak and positive indirect effects on satisfaction and performance for both genders. It can be inferred that communication affects satisfaction and performance indirectly through other factors instead of directly. This is understandable since virtual team members communicate through typing and rarely in real time hence communication affects other factors and in turn affects satisfaction and performance.

**Trust**
Trust can be seen as an important mediative factor for female groups than male groups. From the path coefficients of trust to relationship building in Figure 3 and 4, female model is higher than male model. Furthermore, by observing Appendix 1, trust has higher effects on performance and satisfaction in female model than male model. In addition, both genders build relationship based on the development of trust.

**Relationship building**
Relationship building has strong and direct effects on satisfaction and performance for both groups. For the mediative effects, relationship building received the influence from trust, adds its influence and affects performance and satisfaction. The effect of relationship building is higher in female group than male group by observing Appendix 1.

**Collaboration**
Similar to trust, collaboration can be seen as an important mediative factor for female model than male model. By observing the path coefficients from collaboration to commitment in Figure 3 and 4, the one in female model is higher than that in male model. Furthermore, by observing Appendix 1, collaboration has higher effects on performance and satisfaction in female model than male model. Otherwise, both genders make commitments based on their extent of collaboration.

**Commitment**
Commitment has insignificant path coefficients on performance and satisfaction in female model, while it has an insignificant coefficient on performance but has a significant coefficient on satisfaction in male model. By observing Appendix 1, commitment has similar direct effects on performance and satisfaction in both models, but it has slightly stronger effects in female model than male model after adding the indirect effect. The reason is because of the intense path coefficient from satisfaction to performance. It implies that the phenomenon that higher extent of satisfaction leads higher performance is more obvious for females than males.

From the discussion above, it can be concluded that there is a gender difference in the behavioral pattern (H8 is supported) because of the two reasons:
(1) Table 3 shows that both genders have the identical structural model but distinct measurement model. The researcher believes that the identical structural model came from the equivalent working environment. Mix-gender team composition
drove both genders working in the same team procedure and norm, which causes the identical structural model. But the distinct measurement model implies the different perceptions when they are working together.

(2) Females have overall higher path coefficients and effects on the performance and satisfaction on the factors of trust, relationship building, collaboration and commitment, which means females have a significant preference working in a virtual environment than males. This also strengthens the inference above.

5. Discussion

After the analysis, some interesting findings are explored accompanied with the interview results to explain the issues in depth.

(1) Females have a stronger tendency than males to work virtually

By observing the models and appendix 1, female model shows stronger tendency in social path (communication\(\rightarrow\)trust\(\rightarrow\)relationship building\(\rightarrow\)satisfaction and performance) and task path (communication\(\rightarrow\)collaboration\(\rightarrow\)commitment\(\rightarrow\)satisfaction and performance) than male model. It indicates that females show stronger tendency to work in a virtual environment than males in both social and task dimension.

(2) Females are more adaptive to a virtual environment than males

From the observation of Figure 3 and 4, it can be seen that almost all path coefficients in female model are higher than that of male model. In addition, the figures in Appendix 1 also present the fact that the factors in female model have stronger influences on performance and satisfaction than that of male model. It implies that females have superior abilities to adapt to the virtual environment. Female subjects expressed in the interview regarding to this issue: “I felt more relax to use Blackboard compared to face-to-face meetings”, “I didn’t feel the gender differences during the discussion but I did felt in other normal face-to-face projects”, “I like this kind of communication, I think it is fair and give the equality to girls”, “I can express myself without worrying about others”. From these expressions, females seemed to be very happy and comfortable while they are working virtually. They felt they were freed from the social doctrines and male chauvinism imposed on them compared they were working in a traditional face-to-face environment. In addition, they felt the equality between male counterparts and them. Therefore, the communication technology creates the opportunity for females to working equally and fairly with males.

The traditional communication theories such Media Richness theory [11], Social Identity and Deindividuation (SIDE) model [35], Social Information Processing perspective [66] are incapable of providing the answers of this mystery: “why do females have higher satisfaction while they are working in a virtual team” [36][37]. This study provided the explanation below: while females work with males in a traditional face-to-face environment, they are depressed in a certain degree by the social confinement imposed on them since they were young. But while they are working in virtual teams, they suddenly feel the freedom and liberation due to the boundary-eliminated across genders created by CMC. Therefore, they realize that they are able to play their own side and express what they want to say in a virtual environment, which leads the higher path coefficients in female model and higher effects on performance and satisfaction compared to male model. As to males, they
receive less social depression in their growing history and there is no special feeling for them compared to females when they are working in virtual teams. Thus, the path coefficients for male model and the effects on performance and satisfaction (Appendix 1) are not as significant as females’.

(3) Females regard CMC technology as a tool to avoid conflict

Conflict in virtual teams can be categorized into two main types: social conflict and task conflict [30]. Social conflict involves personal issues such as mutual dislike, personality clashes, and annoyance among team members. Task conflict represents different viewpoints pertaining to the tasks. It includes differences in terms of how the task should be proceeded and issues of duty and resource distribution such as who should do what and how much responsibility each member should take. Social and task conflict has been reported to be detrimental to team performance [27].

Although the models do not show the measurement of conflict, the researcher found an interesting phenomenon that females believed using CMC to communicate is capable of the avoidance of conflict than males. The testimonies from female subjects are as followed. “Using Blackboard can let me think and type carefully; I think it can avoid the conflict”, “Some people like to dominate the conversation and the team, it may raise the fight….. discussing indirectly through typing on the discussion board is hard to lead the argument”, “I feel save, I do not like to argue with my members. I always hold back if it happens. But in the Blackboard I do not need to face the embarrassing situation”. It can be seen that females disfavor conflict especially social conflict. They felt CMC provided a room for members to reduce the opportunity of raising conflict. Females were also found to hold a frigid attitude toward the conflict between members while males were found to tend to mediate or negotiate quarrelling parties to reach the consensus.

Although both genders retain different attitudes toward the conflict, we found that social conflict may be induced by task conflict for both genders. For example, a team comprised of half females and males had an argument regarding to the procedure and responsibility. Although this task conflict had been solved, the members lost interests to improve their social relationships and less social cues had been posted on the discussion board after that, unlike the animated discussion and personal excitement at the beginning. Female and male each in this team had been interviewed and both of them expressed the lower intentions to work with the same members again due to the unpleasant team atmosphere caused by the conflict of task and responsibility distribution.

(4) The intermediate effects of trust, relationships building, collaboration and commitment

Trust is an implicit set of beliefs that refrain from opportunistic behavior and create necessary atmosphere that makes engagement with others more open [54]. Relationships building regards to the team members’ support and well-being [41]. Collaboration focuses on the strategies how team members allocate tasks and negotiate processes [62]. Commitments are based on agreements of what is to be done, who is in charge and the deadline. It focuses on the informal contract that members do what they have promised [52]. These four antecedents form the social path (communication→trust→relationship building→satisfaction, performance) and the task path (communication→collaboration→commitment→satisfaction, performance).
From the social path, it can be seen that virtual team members originate from communicating to form a belief (trust), team support and team well-being (relationship building) while they communicate to allocate and distribute the tasks (collaboration) and furthermore form the informal contract (commitment) by task path. These two paths show the fact that the performance and satisfaction is molded by the four antecedents originated from communication. It means that communication is the prerequisite for virtual teams and it affects the performance and satisfaction through the paths composed by these four antecedents instead of affecting directly. These mediators play very important roles to transmit and enhance/deteriorate the effects on performance and satisfaction. The perception of performance and satisfaction would deteriorate if one mediator does not function well. Thus, to build a successful virtual team needs a comprehensive consideration of all issues.

Some scholars may criticize the model is too complicated since many models tested the direct effects from communication to performance or trust to satisfaction instead of mediating variables. Human’s mentality and behaviors are complex especially hiding behind the computer. Virtual teams are defined as working through CMC instead of meeting face-to-face. Too simple models are incapable of representing the complex human psychology and conducts. In addition, our model incorporates both social and task dimension, which lead a better application both in academic and practical aspect.

6. Conclusions
This research makes three key contributions. Firstly, some interesting differences between genders are revealed. Females appear to be more satisfied and adaptive with the virtual team experience than their male counterparts due to the equitable and fair working atmosphere shaped by CMC. Females’ behaviors emphasize both social and task dimension which combined with intimacy, support and commitment from other team members and a tendency to create consensus with harmony, as opposed to males’ greater inclination to lead and win the discourse and get the facts right.

Secondly, in spite of The Similarity-attraction paradigm suggests both genders are attracted to work with the same gender, it is recommend the gender mixture of virtual team composition. In our observation, females are capable of tendering the working atmosphere and males are focus on the right track to promote the team moving forward. Thus, a team with both genders is able to equilibrate the conflict and lead a better performance.

Thirdly, this study fills the gap existing in the gender issues in virtual team literature as it for the first time aggregates the factors and their relationships in an integrated framework presented in both social and task dimensions. Furthermore, models by multi-group SEM show the importance of the initial factor (communication) and mediators (trust, relationship building, collaboration and commitment) toward the performance and satisfaction of virtual teams, which means none of factors can be ignored in the design and pursuit of virtual team tasks. This finding also encourages the integrated study to form a more complex framework to present the complicated human behaviors due to the poor explanatory power to interpret the conducts hiding in CMC by a simple casual framework.
7. Managerial Applications

Since this research focused on the gender issues in virtual teams, the managerial application is provided for the managers of both online learning context and virtual team works on business. To support female participators requires and understanding of their emotional needs, especially the elimination of inequality caused by the difference of social power. The property “genderless” of CMC is able to create a fairer working environment for females and provide linguistic and social opportunities allowing females adapt to their own norms to support their intercourse interactions. Thus, ensuring the usability and credibility of CMC technology is the first priority of managers. By the researcher’s observation, males do seek social support from other counterparts, but seeking this social support could bring about social inferiority [58], which contributes no performance and satisfaction improvement of virtual teams but may deteriorate them. Additionally, the competition between male members deserves attentions due to it may provide impetus to push the team forward or destruct unity. It is also found that females could conciliate the atmosphere in daggers drawn due to the females’ pursuit of rapport. Thus, a mixed-gender design of virtual teams could be a solution.

At the end, a caveat is called for attention. Although CMC technology provides a “genderless” tool, it does not mean that the interaction through CMC would decrease its complexity nor would CMC simplify the social structure of humankind. Gender differences among face-to-face environment can be also found in the context of various virtual environments (such as email, discussion board, video conference…etc.). Managers should design and manage virtual teams with good flexibility through variety of communication tools and team compositions to ensure the performance and satisfaction of virtual teams.
References


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Canada.


## Appendix 1 Measurement items and scale reliabilities of variables

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Measurement Items</th>
<th>Sources</th>
<th>Reliability (alpha)</th>
</tr>
</thead>
</table>
| Communication       | • I am as interested in building a good relationship as in completing the case study  
                      • I wanted to stick to the main purpose of the discussion                           
                      • I think our group members had effective communication                             | Burgoon and Poire (1999)           | 0.75                |
| Trust               | • We were usually considerate of one another’s feelings on this team                
                      • The people in my group were friendly                                             
                      • I could reply on those with whom I worked in my group                           
                      • Overall, the people in my group were ever trustworthy                           | Jarvenpaa and Leidner (1999)       | 0.88                |
| Collaboration       | • I tried to bring all our concerns out in the open so that the issues could be resolved in the best possible way  
                      • I tried to work with my group members to find solutions that satisfied our expectations  
                      • I exchanged useful information with my group members to solve the problem together  
                      • I tried to investigate an issue with my group members to find a solution acceptable to us | Montoya-Weiss et al. (2001)        | 0.85                |
| Commitment          | • I am committed to my group                                                       
                      • I would feel guilty if I stopped contributing to my group                         
                      • I feel a sense of loyalty to my group                                              | Schmidt et al (2001)               | 0.79                |
| Relationship building | • My group members relied on each other and consulted each other when they needed support  
                          • My group members experienced a sense of shared goals and objectives              
                          • Knowledge and information sharing was understood to be a group norm within my group  
                          • My group was a very cohesive unit                                                 | Lurey and Raisinghani (2001)       | 0.92                |
| Performance         | • My group worked efficiently                                                      
                      • My group met our objectives                                                        
                      • My group generally worked on schedule                                              | Lurey and Raisinghani (2001)       | 0.89                |
| Satisfaction        | • Team members were satisfied with the group’s ability                              
                      • Team members were satisfied with the commitment of the group                      
                      • Team members were confident in the group                                            | Chidambaram (1996);                | 0.86                |
## Appendix 2 Direct and indirect effects on satisfaction and performance

<table>
<thead>
<tr>
<th>Factors</th>
<th>Direct/indirect/total effects</th>
<th>Female Satisfaction</th>
<th>Female Performance</th>
<th>Male Satisfaction</th>
<th>Male Performance</th>
</tr>
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<td>Communication</td>
<td>Direct effect -- -- -- --</td>
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<td>0.04</td>
<td>0.04</td>
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<tr>
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<td>Indirect effect 1: (communication → Trust → relationship building → Satisfaction → Performance) -</td>
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<td>-</td>
<td>0.01</td>
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<tr>
<td></td>
<td>Total effect 0.08 0.15 0.04 0.05</td>
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<tr>
<td>Trust</td>
<td>Direct effect -- -- -- --</td>
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<td>0.11</td>
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<tr>
<td></td>
<td>Indirect effect 2: (Trust → relationship building → Satisfaction → Performance) -</td>
<td>0.19</td>
<td>-</td>
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<tr>
<td></td>
<td>Total 0.36 0.68 0.11 0.13</td>
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<tr>
<td>Relationship building</td>
<td>Direct effect 0.45 0.61 0.32 0.34</td>
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<td>Indirect effect (relationship building → Satisfaction → Performance) -</td>
<td>0.24</td>
<td>-</td>
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<td>Total 0.45 0.85 0.32 0.41</td>
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<tr>
<td>Collaboration</td>
<td>Direct effect -- -- -- --</td>
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<td>0.23</td>
<td>0.37</td>
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<tr>
<td></td>
<td>Indirect effect 1: (Collaboration → Commitment → Satisfaction, Performance) 0.52</td>
<td>0.23</td>
<td>0.37</td>
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<tr>
<td></td>
<td>Indirect effect 2: (Collaboration → Commitment → Satisfaction → Performance) -</td>
<td>0.28</td>
<td>-</td>
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</tr>
<tr>
<td></td>
<td>Total 0.52 0.51 0.37 0.26</td>
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<tr>
<td>Commitment</td>
<td>Direct effect 0.58 0.26 0.52 0.18</td>
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<tr>
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<td>Indirect effect (relationship building → Satisfaction → Performance) -</td>
<td>0.31</td>
<td>-</td>
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<tr>
<td></td>
<td>Total 0.58 0.57 0.52 0.29</td>
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性別差異在以文字溝通的虛擬環境下之研究

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摘 要
針對在虛擬環境中的性別議題是一個新發展的領域。在小群體的研究中發現，對性別差異的感受會影響到群體的互動，進而影響群體的過程與產出。已經探討 Essentialism theory, Similarity-attraction paradigm 和 Individual Difference theory 本研究發展一個模型來評估在一個 text-based 虛擬環境中性別的差異。本研究並設計了一個實驗架構在”Blackboard”系統上。結果顯示出女性對於 relationship building, commitment 和 satisfaction 這三個因素感受較男性深，但對 communication, trust, collaboration 和 performance 這三個因素兩性並無差異。另外，本研究也發現男性與女性在虛擬環境下的行為模式也有所不同，女性對在虛擬環境下工作的調適性和享受態度比男性更高，原因是因為他們感受到了經由電腦通訊所帶來的性別平等。女性也將電腦通訊當作一個降低衝突的工具。

關鍵字：性別差異，虛擬環境，SEM，電腦通訊，虛擬團隊