Personality Traits and Performance in an Online Educational Game

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In this study we explored the relationship among personality traits (based on the Big Five Model), game performance, learning gains, and attitudes of forty-four students who played an educational simulation game online. Half of them played in physically separated dyads following a collaborative script, while the other half played individually. The study also used Analysis of Patterns in Time (APT) to analyze the differences among the highest and lowest performers in each setting.

Theoretical Framework

As the demand for online courses continues to proliferate (Allen & Seaman, 2012), it is necessary to investigate instructional strategies that may promote motivation, engagement, and learning among online students. Two instructional strategies that are known to be effective for promoting engagement and motivation in the traditional setting are cooperative learning (Johnson & Johnson, 1991; Johnson, Johnson, & Smith, 1998; Slavin, 1995) and game-based learning (Garris, Ahlers, & Driskell, 2002; Kirriemuir & McFarlane, 2004; Prensky, 2001). This study explored the effectiveness of the combination of both of these strategies in the online environment.

According to psychology theorists, personality traits, such as the willingness to cooperate and socialize with others, have the potential to influence the quality and level of effectiveness of the collaboration process (Furhnan, 1996; Kichuk & Wiesner, 1997). In general, teams composed of people who are more talkative, tolerant, sociable, cooperative, and gregarious tend to perform better field tasks than teams composed of introverted people (Bell, 2007); however, the relationship between personality traits and task performance varies depending on the nature of the task (Driskell, Hogan, & Salas, 1987).

Multiple studies across several disciplines and academic levels have demonstrated that to facilitate cognitive benefits among all team members, it is critical to include certain elements within the collaboration process, such as individual accountability, positive interdependence, social skills, and group processing (Brush, 1997; Johnson, Johnson & Smith, 1998, Slavin, 1995).

The field of computer-supported collaborative learning (CSCL) combines elements of the collaborative learning theory with the computer-mediated communication theory (CMC) (Kirschner, 2002). CSCL has as a goal to study how people can learn together with the help of computers (Stahl, Koschmann, & Suthers, 2006). Even though the CSCL field emerged since the 1990’s, studies have now proliferated with the growth of online courses. However, the vast majority of CSCL studies have involved asynchronous communication tools (e.g., discussion forums) or text-based synchronous communication (e.g., chat tools). In this study, participants playing in dyads communicated with each other verbally through voice over IP.

Purpose of the Study

The present study was aimed at exploring whether some personality traits were related with performance when playing collaboratively an online educational game. Specifically, the study sought to answer the following research questions:

1) What is the relationship between personality traits and performance, learning and attitude in students playing an online instructional game either individually or collaboratively with a peer?
2) Are there any common patterns in the game play strategies used by higher performing students within each setting (individual or collaborative)?
Methods

Participants

To address these questions, 44 students from a Midwestern University were recruited using the following criteria: (a) be in an undergraduate or graduate academic program, (b) must have not previously played any version of the Diffusion Simulation Game (DSG), which was the online educational game used in the study (c) have no prior knowledge of diffusion of innovations theory (the topic taught by the game) and (d) be a native English speaker. Students were offered eight dollars per hour for a total of three hours of participation. The majority of the recruited students were between 18 and 25 years old (93%), were in college (82%), and stated playing digital games from one to two hours per week (57%).

Context of the Study

This study used an online version of a game called the “Diffusion Simulation Game” (DSG). The DSG teaches concepts and strategies related to the diffusion of innovations theory as described by Rogers (2003). Players take the role of a change agent working at a junior high school. Their mission is to persuade all school staff members to adopt a particular instructional innovation by using the most appropriate activities (e.g., Presentation, Demonstration, and Pilot Test) at the right time and with the right staff members. Figure 1 shows the interface of the DSG version used in this study, which was based on the original board version developed by Molenda and Rice (1979).

![Figure 1. The Diffusion Simulation Game Interface](image)

As it can be seen in figure 1, the interface consists of two main sections. The section on the left side contains the Information Activities and the Diffusion Activities. Each of these activities has a cost in weeks associated with it. After selecting an activity, the weeks are marked off on the calendar, which is included on the top of the right section. Players have up to one academic calendar year, which spans from September to June. Below the calendar, there is the list of staff members that need to be persuaded to adopt the instructional innovation.

Once the player gets personal information about each staff member, players can start classifying them by their adopter type (which includes Innovators, Early Adopters, Early Majority, Late Majority and Laggards). Each staff member needs to get “adoption points” for each of the three stages of adoption (Awareness, Interest, and Trial/Appraisal). The small green squares show the “adoption points” that each staff member has earned so far. The light green buttons represent the adoption points that were earned in the last turn. The green check mark on the “Adopter” column means that the staff member has already become an adopter.

The version of the DSG used in this study is slightly different to the official online version provided by the School of Education at Indiana University. The official online version does not provide multiplayer capabilities and for that reason, the first author developed a new version of the DSG that could be played within the three-
dimensional virtual world called Second Life. Second Life was selected over other technologies for the following reasons (a) Co-browsing capabilities, which allowed all players to see the same screen and share the same progress status; (b) Individual control over some browser elements, which allowed players to scroll up and down within the game interface and to expand collapsible sections without affecting the interface of the other player; and (c) Voice over IP, which allowed players to communicate verbally though their avatars.

Procedure

Students’ participation lasted a total of three hours split into two different sessions. Students attended the first session individually. In the first session, we (1) measured students’ personality traits, (2) measured students’ previous knowledge about the diffusion of innovations theory, (3) collected demographic information about the students and game habits, and (4) assigned students to the individual or collaborative setting. Each of these activities is explained in the following paragraphs.

Personality traits were measured using John’s et al. (2008) Big Five Inventory personality test. This instrument consists of 44 Likert-style items that measure agreeableness, conscientiousness, extraversion, neuroticism, and openness to new experiences. The instrument includes items such as “I am someone who is talkative”. The alpha reliability of this instrument is 0.83.

Student’s previous knowledge about the diffusion of innovation theory was measured by a 15-item pre-test, which included conceptual and procedural questions. The validity of this instrument was measured by having four graduate students with considerable knowledge about the diffusion of innovation theory taking the test. Fleiss’ kappa inter-rater agreement was 0.84.

A survey was used to collect demographic information about the participants such as gender, age, academic level, and game habits. During the first session we also assigned each student to an individual or a dyad setting by flipping a coin. We then paired off students assigned to the dyad setting based on a homogeneous level of agreeableness.

The second session took place within a month after the first one. In this session, students (1) played the DSG several times for eighty minutes in their assigned setting; (2) took a post-test that measured their gains on learning about the diffusion of innovations theory; and (3) submitted an attitudinal survey regarding their reactions about having played the game in the setting they were assigned. Students were asked to play an entire game (from beginning to end) just the first time. After that, they could restart the game at any time they wanted and play as many times within the allotted eighty minutes.

Students playing in dyads were in different locations, did not previously know each other, and used voice over IP to communicate while playing the game online. Based on instructional strategies suggested by the cooperative learning literature (Johnson & Johnson, 1991; Kagan, 1991; Slavin, 1995), dyads were provided with a script to follow in order to encourage positive interdependence, group monitoring, and individual accountability. Moreover, in order to build rapport between the students playing collaboratively, they were given ten minutes to play a collaborative game in which each other attempted to identify some of the commonalities between them (such as having the same kind of pets, liking the same kind of music, or having watched a specific movie recently). The following figure shows the avatars of two participants playing the DSG within Second Life.
In order to analyze the interaction between students playing collaboratively and also the interaction of all players with the game itself, all game sessions were recorded using screencast software. The software also recorded the verbal communication of those playing in pairs. Students in the individual setting were told to think aloud while they were playing and their voice was also recorded. The recordings were mainly used to analyze the patterns in game play strategies between lower and higher performing players per setting.

Findings

In order to address the first research question regarding the relationship between personality traits and performance, learning and attitude in students playing individually or collaboratively, we conducted several bivariate correlational analyses.

Personality traits and Game Performance

Game performance was measured by the average score across all the complete games played by teams and individual players. In the individual setting, the only personality trait that was related to game performance was conscientiousness, and this relation was marginally significant ($r = 0.390, p = 0.073, n = 22$). This result was aligned with the literature of personality psychology in the sense that people who perceived themselves as highly responsible, reliable, and tenacious are associated with improved task performance (Bell, 2007).

In the collaborative setting we controlled only for the level of agreeableness to pair students. Based in the literature of personality psychology, we had hypothesized that teams with high level of agreeableness would perform significantly higher. However, contrary to this hypothesis, participants’ levels of agreeableness were negatively correlated with their game performance ($r = -0.411, p = 0.058, n = 22$). This indicated that teams in which both students perceived themselves as highly polite, tolerant, and trustful had the lowest scores.

An unexpected finding from the collaborative setting was that the participants’ level of extraversion, which refers to the level of sociability, gregariousness, and talkativeness was also negatively correlated to their game performance ($r = -0.459, p = 0.032, n = 22$). This finding was unexpected because the dyads formation did not control for this personality trait. This finding indicated that dyads with a higher level of extraversion obtained lower game scores than dyads with a lower level of extraversion.

As we had been predicted it based on the literature of cooperative learning, the average game scores of students playing collaboratively was statistically significantly higher than those playing individually, $t(31) = 1.711, p = .0485$ (1-tailed).
Personality Traits and Gains in Learning

Gains in learning were measured by the difference between the post-test and the pre-test scores. Both tests were taken individually. In the individual setting, the level of extraversion was the only personality trait found to be significantly correlated to learning gains ($r = -0.478$, $p = 0.025$). This correlation was negative, which indicated that students who perceived themselves as more introverted tended to gain significantly more knowledge than those who were more extraverted.

For participants in the collaborative setting, there were two personality traits that were marginally significantly correlated to their learning gains: conscientiousness ($r = 0.37$, $p = 0.09$, $n = 22$), and openness to experience ($r = 0.39$, $p = 0.073$, $n = 22$). This result indicated that participants who perceived themselves as more responsible, reliable, and creative obtained higher gains in learning.

Personality Traits and Students’ Attitudes

Participants’ attitudes towards their learning experience were measured by a reactionnaire that included several Likert scale items and an open-ended question. The Likert items were divided into two sets. The first set consisted of six items measuring the participants’ level of enjoyment playing the DSG. It included items such as “I enjoyed Playing the Game” and “If given the chance, I’d like to play the game again”. The Cronbach’s alpha reliability of the scale measuring the level of enjoyment was 0.805.

The second set of items was used to measure the extent participants liked playing in the setting they were assigned, either individual or collaborative. These questions varied slightly per setting. For instance, for participants playing collaboratively, one of the items read: “I felt more motivated playing the DSG as part of a team than if I had played alone”, whereas for participants playing individually, the corresponding item read: “I feel that I would have been more motivated playing this game with somebody else instead of playing it alone.” Some of these items were adapted from an attitudinal survey used by Brewer and Klein (2006).

On average, regardless of the setting they were assigned, most participants agreed having enjoyed playing the game, wanting to play more, and considered that playing the game was an effective way to learn. In the individual setting, the only personality trait that was statistically correlated to the participants’ attitudes toward having played the game individually was their level of agreeableness ($r = -0.421$, $p = 0.051$, $n = 22$). This result indicated that students who did not consider themselves very cooperative and supportive to others, preferred playing the game alone. Students playing in teams exhibited a significant correlation in their level of extraversion ($r = 0.567$, $p = 0.006$) and neuroticism ($r = 0.466$, $p = 0.029$). This finding indicated that students who perceived themselves as more sociable, talkative, and emotionally stable tended to prefer playing the game in a team.

Common Patterns in Game Play Strategies per Setting

The second research question involved investigating common patterns in the game play strategies used by students with the highest and lowest scores per setting (individual and collaborative). The recordings of all the games played by the students with the top two and the lowest two average scores were transcribed. The game scores were calculated based upon the average number of “adoption points” obtained across all complete games played. Table 1 shows the total number of games played by these students and their average game score.

<table>
<thead>
<tr>
<th>Teams</th>
<th>Total Games Played</th>
<th>Complete Games Played</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top 2 Teams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 1</td>
<td>4</td>
<td>4</td>
<td>9.15</td>
</tr>
<tr>
<td>Team 11</td>
<td>9</td>
<td>3</td>
<td>8.91</td>
</tr>
<tr>
<td>Bottom 2 Teams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 10</td>
<td>6</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Team 11</td>
<td>6</td>
<td>3</td>
<td>6.93</td>
</tr>
<tr>
<td>Top 2 Individuals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Player 16</td>
<td>4</td>
<td>3</td>
<td>9.24</td>
</tr>
<tr>
<td>Player 22</td>
<td>9</td>
<td>3</td>
<td>9.23</td>
</tr>
<tr>
<td>Bottom 2 Individuals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Player 13</td>
<td>5</td>
<td>3</td>
<td>5.01</td>
</tr>
<tr>
<td>Player 22</td>
<td>6</td>
<td>3</td>
<td>4.31</td>
</tr>
</tbody>
</table>

Analysis of Patterns in Time (APT), which is a method of recording and quantifying temporal relations about observable phenomena (Frick, 1990), was used to identify patterns between players with the highest and
lowest scores in both settings. In APT, patterns are identified by counting the occurrences of multiple states that characterized the phenomena or event observed (Frick, 1983). A set of states that are mutually exclusive and exhaustive comprises what Frick (1983) defines as a “classification” in APT.

Some of the APT classifications used for the analysis of patterns in the collaborative setting were adapted from the literature in interaction and discourse analysis (Gunawardena, Lowe, and Anderson, 1997; Hara, Bonk, & Angeli, 2000; Henry, 1992; Herring, Kutz, Paolillo, & Zelenkaukaite, 2009), and some others were observed when analyzing the game plays. Table 2 condenses these APT classifications.

Table 2
List of classifications used for APT analysis in the collaborative setting

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration level</td>
<td>Extent to which team mates collaborated in deciding the activity to conduct in a turn.</td>
</tr>
<tr>
<td>Decider</td>
<td>Player(s) who made the decision to conduct the activity in the turn.</td>
</tr>
<tr>
<td>Suggestions</td>
<td>Player(s) who made suggestions during the turn.</td>
</tr>
<tr>
<td>Turn Reason</td>
<td>Reason why dyads selected the activity conducted in each turn.</td>
</tr>
<tr>
<td>Diffusion Strategy Selection</td>
<td>Whether the activity conducted was appropriate according to diffusion of innovations theory (i.e., in order to succeed in the game).</td>
</tr>
</tbody>
</table>

Each of the classifications shown in Table 2 had a set of categories associated with them. For instance, the categories associated with Collaboration Level are included in Table 3.

Table 3
Categories in the Collaboration Level classification

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negotiation (N)</td>
<td>The activity is conducted as a result of dialog or discussion between players that includes sharing information, elaborating a suggestion, expressing different opinions, participating in the decision process, and identifying inconsistencies.</td>
</tr>
<tr>
<td>Passive Negotiation (PN)</td>
<td>A player suggests conducting an activity and the other player consents without any dialog. The suggestion is usually presented as a question.</td>
</tr>
<tr>
<td>Unilateral Decision (U)</td>
<td>In his/her turn, a player conducts an activity (which was not previously discussed) without the other player’s opinion.</td>
</tr>
<tr>
<td>Command (C)</td>
<td>In the other player’s turn, a player commands him/her to conduct an activity.</td>
</tr>
</tbody>
</table>

Each game turn of all complete games played by the top two and the lowest two teams and individual players were coded using the categories for each of the identified APT classifications. A second rater analyzed and coded ten percent of random selected turns independently in order to calculate inter-rater reliability. On average, the Cohen’s Kappa coefficient across all APT classifications was 0.73.

Based on the APT analysis, it was possible to observe that in both settings, the main differences between the higher and lower performing dyads regarding the reasons for conducting an activity were that the higher performing dyads conducted more activities as a result of an externalized cognitive process and of applying what they have learned from previous turns. For example, on average, higher performing dyads conducted 1.85 times more activities that were result of a cognitive process and 1.76 times more activities that had been previously identified as being effective, compared with low performers. Moreover, in terms of the reasons for conducting ineffective strategies, the lowest performing dyads conducted 2.5 times more unsuccessful activities for failing to observe information or hints on the feedback provided.

By counting the number of occurrences in which game turns had been coded as “Negotiation”, it was observed that, on average, the higher performing teams had conducted almost twice as many negotiated turns than the lower performing teams. On the other hand, lower performing teams had 1.42 more turns using passive negotiation and had more than twice as many turns that used unilateral decisions.

Regarding the number of suggestions made by players, through APT it was observed that on average, compared to the lower performing teams, higher performing teams conducted 1.84 more turns in which both players
made suggestions. In contrast, lower performing teams conducted 1.43 more turns in which neither player made any suggestion.

In the individual setting, participants with the highest average score across all their games conducted effective turns that were result of an externalized cognitive process 2.6 times more often than participants with the lowest average score. Moreover, higher performing individual players conducted twice as many activities that had been previously identified as being effective. Lower performing individual players were over three times more likely to repeat non-effective activities due to having forgotten information or feedback about the previous activities conducted.

Conclusions

In this study we explored (1) how personality traits correspond with performance, learning, and attitude in students playing the DSG individually and collaboratively and (2) pattern differences between higher and lower performing players.

In partial agreement with personality psychology literature, conscientiousness was found to be marginally significant to game performance in the individual setting ($r = .390$, $p = .073$, $n = 22$). However, contrary to expectations, in the collaborative setting the levels of extraversion and agreeableness were negatively correlated to their game performance ($r = -.459$, $p = .032$, $n = 22$ and $r = -.411$, $p = .058$, $n = 22$ respectively).

When playing the DSG, dyads with a lower level of agreeableness exhibited more negotiation in each game turn whereas those with a higher level accepted passively more suggestions put forward by their teammates. In general, dyads with a lower level of agreeableness had more cognitive disagreement, corrected each other’s mistakes more often, and offered more suggestions.

Regarding the relationship between personality traits and gains in learning, extraversion was found to be negatively correlated in those playing individually ($r = -.478$, $p = .025$, $n = 22$). This finding indicated that, regardless of their game performance, individual participants who perceived themselves as more introverted and reserved obtained higher gains in learning. An analogous correlation was not found in the collaborative setting. In other words, extraverts playing in dyads did not exhibit greater gains in learning.

Pattern differences were analyzed using APT. In both settings, a relevant difference between the higher and the lower performing participants was the number of turns that were conducted as a result of a cognitive process externalized by either thinking aloud, in the case of the individual setting, or by talking to a teammate, in the case of the collaborative setting. This difference was more pronounced in the individual setting, in which higher performing participants conducted 2.6 times more cognitive-related turns than lower performing participants.

In addition, in both settings, lower performing participants conducted ineffective turns more often than higher performing participants. On average, they conducted 2.5 times more turns that were ineffective for failing to notice information or hints on the feedback provided in the game.

In the present study, it was found that participants who were more actively involved in the decision-making process and who had a higher frequency of communication, exhibited greater gains in learning. Tsay & Brady (2010) reported a similar finding after observing that students participating more actively in a team-based learning course had also obtained higher scores. Ensuring a more active participation by all team members could thus be desirable in synchronous collaborative educational games.

Limitations

A main limitation of this study is not generalizable to any other contexts. The study used a specific problem-solving activity that consisted of using the Diffusion Simulation Game as the educational game instance. Each educational game has a different level of complexity, underlying instructional information, rules and mechanics, and expected outcomes.

A second limitation is its relatively small number of participants. The study compared two groups that included only 22 participants each. Increasing the number of participants per group could have also increased the statistical power of the study.

An additional limitation is that the study did not measure long-term learning. The participants took the post-test immediately after playing the DSG during an 80-minute period. They did not take another follow up test weeks later. Such a test would have allowed comparing long-term retention based on the setting assigned.
References


