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On the Effectiveness of a Simulated Learning Environment

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Abstract

Although the push toward competency-based higher education is strong and increasing over the years (see e.g. Christensen & Eyring, 2011), teaching and learning competencies at the university is a demanding challenge for both students and teachers. Computer simulations are a promising way to achieve this goal, but their effectiveness is far from conclusive (Bell, Kanar, & Kozlowski, 2008). In this study, we present an investigation of the impact of a distance learning class that employed vLeader, a computer simulator, as the main learning tool. vLeader allows users to interact with artificially intelligent avatars in order to solve complex organizational problems in a social context. Forty-five students participated in the class on leadership and filled out surveys before and after the class. Effectiveness was measured in a pre-post-test design by employing both transactional and transformational self-reported leadership behaviors. We also collected measures of fluid intelligence and extraversion to control inter-individual differences in learning proficiency, dynamism and dominance. Results suggest that the effectiveness of the simulator is moderated by students' implicit and explicit extraversion, such that more introverted students improved more in three scales of the Multifactor Leadership Questionnaire (Bass & Avolio, 1997): 1) "Outcomes of leadership" (Extra effort, Perceived Effectiveness and Satisfaction); 2) Individualized Consideration and 3) Laissez-Faire Leadership Style, which decreased from time 1 to time 2. Theoretical and practical implications of these results are discussed.

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Keywords: Leadership; Computer-based simulation; E-Learning.

1. Introduction

One aspect that should be underlined when discussing the pros and cons of implementing training simulators is that the use of technology does not guarantee success. The meta-analysis conducted by Girard et al. (2013) concludes that the effectiveness of serious, educational games has yet to be proven; the technologies used, learning

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contexts and objectives are different in the studies and the results sometimes controversial. This does not mean that they could not be a powerful learning tool (Wouters, et al., 2013), able to engage and motivate students (Annetta et al., 2010). The learning context, the use of games in a training program, a high level of students' energy, reflection and time availability are all elements that Sitzmann (2011) points out as factors that have a positive impact on learning.

For example, in a computer-based training there is a transfer of responsibility from the trainer to the trainee. Sometimes, too much control by the student has a negative impact on learning (Kraiger & Jerden, 2007; DeRouin, Fritzsche, & Salas, 2004). However, self-paced learner control (DeRouin, Fritzsche, & Salas, 2005) appears to be more positive for skill-based training or new contents. Giving control to trainees increases intrinsic motivation to learn and produces positive attitudes toward the learning experience (Fisher, Wasserman, & Orvis, 2010). As for the effects of trainee control on learning, however, the results are mixed (Vogel & Vogel, 2006; Van Nimwegen & Van Der Spek, 2013).

In the context of simulations, where students have more control over their own learning, individual differences play an important role in determining the subject's response to the simulation (Goh, 2008; Brown, 2001; DeRouin, Fritzsche, & Salas 2004; Anderson, 2005; Bell & Kozlowski, 2007; Sitzmann et al. 2008). There are a number of individual differences such as personality traits, cognitive ability, goal orientation, anxiety, self-efficacy, motivation, learner control preferences that will impact the success of the training design (Bell & Kozlowski, 2010; Kraiger & Jerden, 2007; Salas, 2001). Our goal in the present study is to assess the effectiveness of a simulation-based computer-assisted learning integrated with other didactic strategies in a university class. Given the nature of the class, focused on training and evaluation of human resources in educational context, it is important to provide students with the opportunity to explore the organizational context and to develop practical skills.

Simulation is a form of realistic training that uses a simplified representation of working life to support accelerated learning processes. In this context, it is evident that testing the effectiveness of different programs and analyzing their success factors is crucial for the development of an evidence-based educational science. The distance learning class analyzed in this work employed a computer simulator as the primary tool for the effective management of leadership behaviors. Looking at the connection between leadership style and personality measures (Costa & McCrae, 1988; Watson & Clark, 1997; Judge & Bono, 2000) we assessed change in individual self-perception and leadership behaviors showed by students involved in a computer-based simulation training.

The simulation employed in our class is called vLeader, which is a commercial simulator developed and distributed by Simulearn Inc. The simulation is composed of an introductory part in which users are provided with the context of the simulation (just been hired to lead the call center of a big company) and are acquainted with the controls and affordances they will have throughout the whole simulation. Then, three more exercises are proposed, designed to teach some basic principles of leadership: leadership styles (directive, participative, delegative), the relationship between stress and productivity and between stress and creativity, the ability to manage stress, the acquisition and sharing of power, the creation of alliances, the differences between task and relationship orientation. This introductory part takes about 2 hours of interactive practice. The second part of the simulation consists of five scenarios in which some objectives to be achieved during a meeting are assigned to users who join the simulated meeting, and interact with other characters (colleagues) to achieve their goals. What users can do here is to support or object to ideas and characters by clicking respectively on the green and red sides of the bar that appears for each character and idea. By clicking on the center of the bar an idea is brought into the discussion or the character is given the opportunity to speak without expressing support or opposition. Characters and ideas are briefly described when the simulation is paused. These descriptions provide some hints on the habits and personality of the characters and the impact of the ideas on customer satisfaction, employee satisfaction and financial performance. The main parameters along which the dynamics of interaction changes are the level of tension in the room, the power of the user (personal influence) and the opinion that the group (people in the room) has about the user. These parameters change at each action. For instance, introducing an idea needs power and therefore the power level of the user decreases. On the contrary, when an idea supported by the user is approved, power increases. Characters in the room behave according to these parameters, their relationships with the other characters and the user, and their opinion on the ideas discussed.

1.1. Simulation-based Training

Simulation-based training (SBT) is a learning methodology that allows to improve management skills earlier in career (Salas, 2009). "SBT can be conceptualized as any synthetic practice environment that is created in order to impart these competencies (attitudes, concepts, knowledge, rules, or skills) that will improve a trainee's performance" (*ibidem*). vLeader consists of five modules putting students in a leadership position and requiring their social interaction with co-workers in a business meeting.

This kind of technology can impact behavioral and complex skills implementing competencies in a learner-controlled training. This can speed up the development of skills and improve the ability to apply what learned to real life thanks to a rich simulation environment. Simulation also offers a balance between the complexity of real world and the simplicity of game design, thus making training enjoyable and easy to manage. It is also possible to implement innovative or risky decision making without real consequences (Annetta et al., 2010). For example, in the simulation adopted in the present study, the scenario describes the catastrophic failure of a subsidiary company, and students have the opportunity to deal with rare situations without risk. Finally, this technique could be more engaging than traditional passive methods.

The first element which characterizes a training simulation is the idea that a person can become a real individual when playing the game. Students not engaged in the environment are insensitive to the other elements of SEG design. People interact with the simulation environment through an avatar in a third-person perspective. Annetta and Holmes (2006) pointed out that the possibility to choose an avatar increases the perception of social presence and builds a strong community of practice. If the player does not have a sense of identity, the other elements of the design can be much less influential.

The second element is immersion, being immersed means that players have a sense of individual identity, are engaged and intrinsically motivated. In this condition players may experience flow (Csikszentmihalyi, 1990). Flow is one of the most important goal for game designers. We do not have specific information regarding the nature of the experience that our students lived while using practicing at the simulator, but monitoring their progress and talking with them about how they felt during the game, we had a feeling that at least some of them experienced some peculiar components of flow experience, such as clear goals and immediate feedback, a high level of concentration on a few aspects of the game, and a somewhat altered perception of time. The perception of immersion depends on the degree to which people find games satisfying. At this level, it is important that the design facilitates the interaction of people with the environment (user friendly interface) and that they get feedback on contents and performance. In particular, our students get social feedback on their performance, through verbal and nonverbal stimuli expressed by other participants in the simulation. The characters with whom players interact show their feelings by yawning, shaking their head or beating their fists on the table, all reactions that in everyday life are related to specific emotions. Answers or verbal stimuli provide an evaluation of the performance, the choices and behaviors of the player.

The third element is interactivity. The simulation used in the study sees the player interacting only with the machine, therefore communicating with non-player characters Despite the absence of a multi-player environment, players can still experience the classic effects of social inhibition in the performance reacting to characters as if they were real people (Hoyt, Blascovich, & Swinth, 2003).

Another characteristic of a good SEG is an organization with increasing levels of complexity. vLeader is a single-player simulation, where the other part of the duo is the machine and it is organized into five levels of increasing complexity. This design makes it possible to replicate the learning objectives and actions of exploration of the environment. It is important that students' progress in a balance of pleasurable frustration (Gee, 2004). Well-designed games are based on a system of core competencies, which means that participants are challenged but the challenge is not so difficult to bring the player to believe that it is impossible, a concept very close to that of Vygotsky's (1978) zone of proximal development.

The fifth element of a SEG is the possibility to assess students learning through performance. It produces virtual observations giving information on teaching and learning. Finally, serious educational games are instructive. Learning is self-regulated; players connect new experience to prior knowledge and experiences, assimilating new contents incorporated in the simulation. To facilitate this process, students are involved in a reflective practice: they keep a journal reporting what they have learned and its transferability to other contexts.

2. Method

2.1. Training Intervention

Participants were involved in an experiential leadership training workshop. The workshop, which lasted a month, was an integral part of a human resources management course. Part of the program consists of lectures, with presentation of the theoretical content. A second part consists of simulated autonomous and individual work. Each student had his own tutor for the simulation, whose task was to promote learning, providing explanations, monitoring the individual progression in the simulation, identifying strengths and weaknesses, and supporting, even at the motivational level, students in their path. The students (all female) carried out simulations in autonomy on their personal computers. Before and after the exercises they had to describe the goal of their action and their reflections on the results. Right after each scenario, students were invited to write a Learning Journal in which they were supposed to report and identify a learning event, the emotions associated with that event, and what they had learned from that event. The participation in the research survey was mandatory and the research was carried out to test the effectiveness of the simulation. Students were rewarded with university credits.

2.2. Participants and Procedure

Fifty-five students used vLeader during their class and were asked to fill out pre and post surveys, forty-five filled out both pre and post questionnaires. In order to examine the change in their leadership style we measured Transactional and Transformational Leadership before and after the intervention. Also, we decided to control for personality predictors of leadership behavior and for inter-individual differences in learning abilities. Hence, we included the Advanced Progressive Matrices (APM, Raven, Raven & Court, 1998) as a measure of fluid intelligence in the pre-test survey. In addition, we collected explicit and implicit measures of extraversion at each time. There is an extant literature showing that behavioral differences in leadership can depend on background characteristics (e.g. Avolio & Gibbons, 1988). Indeed, Extraversion is strongly related to social leadership (Costa & McCrae, 1988), leader emergence in groups (Watson & Clark, 1997), and transformational leadership (Judge & Bono, 2000). Hence we decided to add Extraversion and its facets as control variables in our analysis.

All the students of the course were asked to take the test through a link available on the platform of the course. Forty-nine students completed the first test, while forty-six students completed the second test. Forty-five of them had also completed pre-test measures and were therefore included in the final analysis. All measures were counterbalanced between subjects.

2.3. Measures

Extraversion. Dominance and dynamism were measured with the 24-item BFQ Big Five Questionnaire 2 (Caprara et al., 2008), with five-point scale from 1 “Disagree” to 5 “Agree”. Participants scoring high on energy tend to describe themselves as very dynamic, talkative, active, energetic, and dominant. People with lower scores, on the other hand, tend to describe themselves as not very dynamic, not very active or energetic, submissive and taciturn. Dynamism reveals energetic and dynamic behaviors, vitality, ease of speech, sociability and enthusiasm. Dominance reveals the ability to stand out, to excel, to assert influence.

Implicit Extraversion. Implicit extraversion was measured using the Implicit Association Test (IAT, Greenwald, McGhee, & Schwartz, 1998). Researches on personality have been using implicit techniques since Greenwald et al. (2002) and they have been extensively discussed in Schnabel et al. (2008). The interested reader is referred to this article and to https://implicit.harvard.edu/implicit/ for demonstration tests. The IAT is a two-choice discrimination task, where stimuli have to be categorized as belonging to two categories, object or attribute, by pressing a button as quickly and accurate as possible. The two nominal categories were defined by words related to the “Me” vs “Others” dichotomy (concepts) and the “Extroverted vs. Introverted” attributes. The difference between the average reaction time in the combined task I-Extraverted and the average reaction time in the combined task I-Introverted is the main dependent variable (IAT score computed according to Greenwald, Nosek, Banaji, 2003). Positive differences indicate a stronger association between me and introversion, negative differences indicate a stronger association between me and extraversion. Participants used the letters A and L for discrimination. Target and

attribute labels assigned to the keys were shown in the left and right upper corners of the computer screen throughout each task. The stimuli were presented in the center of the screen until the participant responded. The stimuli for the two IATs are presented in Table 1. The stimuli for category “Me” were name, surname, “I”, “Me” and “My”, for “Other” were “Other”, “You”, “Them”, “They”. Extroverted was represented by "active", "energetic", "dynamic", "dominant", "talkative" and "extroverted" items. Stimuli for Introverted were "passive", "reserved", "quiet", "introverted", "shy", and "quiet". Higher scores at this measure reflect stronger association between the self and Introversion.

Table 1. Blocks of trials provided in introverted IAT .

	no. of trial	Task	Left key	Right key
B1 (practice)	20	Target discrimination	Me	Other
B2 (practice)	20	Attributed discrimination	Introverted	Extraverted
B3 and B4 (test)	20+36	Initial combined task	Me - Introverted	Other - Extraverted
B5 (practice)	30	Target discrimination	Other	Me
B6 and B7 (test)	20+36	Reversed combined task	Other- Introverted	Me - Extraverted

Leadership. The following constructs were measured with 45 items translated by MLQ – 5x. This latest version has some corrections to the previous limitations, assessing the dimensions corresponding to Bass’ theory (1985). These items were evaluated on a 5-point scale ranging from 1 “not at all” to 5 “frequently” with an additional response option “I do not know - Not applicable”.

Transformational leadership behaviors were measured with 20 items from the Multifactor Leadership Questionnaire (Avolio & Bass, 2004), four for each dimension: idealized influence-attributed, idealized influence-behavior (IIAI and IIBI), inspirational motivation (IM) and individualized consideration (IC). Transformational leaders are charismatic, inspirational, intellectually stimulating, challenging, visionary, development oriented, and determined to maximize performance. Transformational leaders are proactive, they try to optimize on individuals (IC), the group and organizational development and innovation. They convince their associates to strive for excellence; they are optimistic and enthusiastic (IM). Finally, they are admired and respected (IIAI, IIBI).

Transactional leadership behaviors were measured with 8 items from the Multifactor Leadership Questionnaire *(*Avolio & Bass, 2004*)*, four for each subscale: Contingent Reward (CR) and Management by Exception-Active (MBEA). Transactional leader work with individuals and groups to achieve specific objectives, they identify individual skills and reward their achievements. They utilize corrective (MBEA) and constructive behaviors (CR). Transactional leaders clarify expectations and provide recognition (CR), closely monitor deviances, mistakes and errors (MBEA). In the passive form they show inactive or avoidant leadership behaviors.

Passive or avoidant leadership style were measured with the participants' answers to two subscales from the Multifactor Leadership Questionnaire (Avolio & Bass, 2004): Management by Exception-Passive (MBEP, 4-item) and Laissez-Faire (LF, 4-item). Passive leaders don’t specify agreements, expectations, and provide no goals or standards. Finally, they avoid to respond immediately to problems.

Outcomes of leadership were measured with nine items from the Multifactor Leadership Questionnaire (Avolio & Bass, 2004), three measured for Extra Efforts, four for Effectiveness and the last two for Satisfaction. Transactional and transformational leaderships are positively associated with the success of the group. They are positively related to both transactional and transformational leadership. Extra Effort is related to the ability to make others do more than they are expected to do. Effectiveness measures the perception of personal effectiveness and that of the group. Finally, satisfaction is related to work and leadership style.

*Advanced Progressive Matrices, APM 47 (Raven, Raven & Court, 1998).*This test assesses the ability of a person to identify, after observing meaningless images, a relationship between them, by imagining the nature the image in its entirety and completing each system of relations presented through a systematic method of reasoning. There are two series of APMs, the first of which has 12 items, which aim to introduce the subject to the working method and help him to understand the mental process necessary to solve all the items of the second series. In the second series there are 36 items whose presentation and task are identical to those of the first series; but matrices are progressively more difficult. Our application has used the twelve matrices of practice of the first series and the first sixteen items of the second series: 28 matrices that were solved by the subjects within 20 minutes.

Table 2. Correlations between measures. Correlations at the pre-test are shown under the main diagonal. Correlations at the post-test are shown above the main diagonal. Values on the main diagonal provide test-retest correlations between the same measure.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
APM	1.00																				
BFQ-Extraversion	.18	.82**	.76**	.87**	.34*	.06	.28	.36*	.27	.17	.08	.14	.01	-.13	-.15	-.07	.15	.27	.15	-.06	-.14
Dynamism	.18	.82**	.68**	.35*	.38**	.15	.37*	.49**	.10	.19	-.10	.13	-.24	-.13	-.15	-.08	.06	.16	-.03	-.02	-.16
Dominance	.13	.87**	.44**	.80**	.21	-.02	.13	.15	.31*	.10	.19	.11	.19	-.08	-.10	-.04	.17	.31	.24	-.07	-.07
Transformational Leadership	.04	.29	.29	.21	.57**	.64**	.76**	.60**	.74**	.64**	.46**	.54**	.25	-.20	-.08	-.31*	.61**	.46**	.49**	.30*	.02
Idealized Influence Attributed	.07	.36*	.29	.31*	.72**	.38**	.40**	.37*	.32*	.15	.22	.20	.16	-.08	-.02	-.13	.46**	.33**	.19	.33*	.09
Idealized Influence Behavior	.03	.11	.09	.10	.65**	.29	.40**	.42**	.41**	.41**	.27	.33*	.15	-.18	-.116	-.22	.37*	.36**	.26	.13	.07
Inspirational Motivation	-.07	.37*	,52**	.14	.62**	.37*	.14	.45**	.20	.03	.14	.29	-,011	.07	.156	-,06	.28	.23	.23	.02	-.22
Intellectual Stimulation	.04	.21	.17	.19	.80**	.53**	.51**	.36*	.51**	.52**	.49**	.46**	.36*	-.28	-.180	-.33*	.52**	.43*	.53**	.26	.01
Individualized Consideration	.06	-.06	-.08	-.03	.63**	.24	.32*	.24	.34*	.50**	.39**	.52**	.16	-.21	-.103	-.30*	.43**	.25	.40**	.28	.16
Transactional Leadership	.13	.22	-.04	.39**	.41**	.19	.40**	-.04	.53**	.37*	.61**	.77**	.87**	-.23	-.04	-.40**	.46**	.37*	.57**	.09	.08
Contingent Reward	.21	.24	.02	.37*	.47**	.23	.36*	.11	.47**	.49**	.70**	.59**	.34*	-.25	-.07	-.41**	.58**	.41*	.60**	.23	-.06
Management by exception Active	-.01	.08	-.07	.19	.14	.05	.22	-.16	.30*	.08	.74**	.04	.47**	-.14	-.01	-.27	.22	.02	.37*	-.04	.16
Passive	-.37*	-.15	-.26	-.02	-.24	.07	-.31*	-.14	-.25	-.19	-.08	-.13	.00	.64**	.91**	.85**	-.24	-.34*	-.12	-.20	.02
Management by exception Passive	-.30*	-.04	-.18	.10	-.07	.14	-.16	-.06	-.17	.00	.10	.08	.06	.87**	.56**	.56**	-,03	-.02	.08	-.06	.03
Laissez faire	-.32*	-.24	-.25	-.16	-.36*	-.04	-.39**	-.20	-.26	-.37*	-.28	-.35*	-.08	.79**	.40**	.67**	-.45	-.41**	-.34*	-.32*	-.01
Outcome	.09	.48**	.42**	.43**	.71**	.64**	.44**	.42**	.61**	.37*	.49**	.59**	.13	-.12	.10	-.35*	.43**	.38**	.73**	.74**	.06
Efficacy	.19	.43**	.39**	.37*	.61**	.65**	.52**	.27	.44**	.25*	.37*	.45**	.90	-.19	.33	-.40**	.73**	.54**	.18	.25	-.01
Extra Effort	-.05	.29	.25	.26	.68**	.58**	.28	.46**	.59**	.46**	.41**	.47**	.13	.09	.18	-.05	.76**	.28	.41**	.27	-.01
Satisfaction	.23	.23	.12	.27	.28	.28	.11	.17	.43**	-.02	.36*	.37*	.15	-.14	.03	-.31*	.58**	.49**	.18	.28	.13
Implicit introversion	.00	-.14	-.29	.03	-.02	.13	.12	-.25	.19	-.24	.14	.10	.09	.01	-.08	.13	-.04	-.04	-.02	.01	.62**

** $p < .01$, * $p < .05$

The first response was used as an example, therefore it was not included in our analysis.

Table 3. Descriptive Statistics and alpha coefficients for variables at Pre-test and Post-test.

	M_1	DS_1	α_1	M_2	DS_2	α_2
Intelligence	19.80	4.90	/	/	/	/
Dynamism	46.76	6.25	0.8	46.07	4.6	0.7
Dominance	36.11	7.21	0.8	37.42	6.2	0.8
Idealized Influence Attributed (IIAI)	3.92	0.48	0.5	4.06	0.4	0.5
Idealized Influence Behavior (IIBI)	4.28	0.43	0.5	4.27	0.4	0.5
Inspirational Motivation (IM)	4.13	0.47	0.5	4.08	0.4	0.6
Intellectual Stimulation (IS)	4.07	0.46	0.5	4.14	0.5	0.7
Individualized Consideration (IC)	4.28	0.47	0.4	4.24	0.4	0.6
Contingent Reward (CR)	3.85	0.69	0.5	3.97	0.5	0.6
Management by exception Active (MBEA)	3.34	0.73	0.7	3.39	0.7	0.7
Management by exception Passive (MBEP)	2.03	0.67	0.6	2.03	0.6	0.6
Laissez faire (LF)	1.83	0.53	0.6	1.86	0.5	0.5
Extra Effort (EE)	3.77	0.60	0.7	3.73	0.5	0.6
Effectiveness (EFF)	3.98	0.39	0.2	4.01	0.3	0.5
Satisfaction (SA)	4.06	0.47	0.6	4.02	0.5	0.1
Energy (BFQ)	82.87	11.45	0.8	83.49	8.9	0.8
Transformational Leadership	4.14	0.32	0.8	4.16	0.3	0.8
Transactional Leadership	3.60	0.51	0.5	3.68	0.5	0.7
Passive Leadership	1.93	0.50	0.7	1.95	0.5	0.7
Outcome	3.94	0.36	0.7	3.92	0.3	0.7
Implicit Introversion (IAT)	0.26	0.42	0.7	0.20	0.4	/

Note. Self-report scales ranged from 1 to 5. IAT scores typically range from -2 to 2. Scores at the APM range from 0 to 27.

3. Results

With regard to the APMs, on average students answered to 73% of the questions correctly. One person provided only one correct answer and was excluded from subsequent analysis involving this measure. The maximum observed score at APM-47 is 26, the minimum is 8.

We have evaluated the internal consistency of each measure by calculating Cronbach's alpha coefficient. Table 3 shows descriptive statistics and the reliability of each measure of the study. The internal reliability coefficients of the MLQ measures are quite low. Specifically, we observed very low alpha coefficients for effectiveness (α_1= 0.27; α_2=0.56) and satisfaction (α_1= 0.61; α_2=0.19). The lack of internal consistency may be due to the translation, since for the original scale there is evidence of higher reliability. To assess the overall effects of leadership training we ran a repeated measure t-test comparing leadership styles for the two observation points (before and after the class). Examination of the data revealed only marginal changes from pre-test to post-test. Hence, we investigated whether the effectiveness of the training simulator was moderated by students' intelligence or extraversion. While we found no significant moderation effect of intelligence (perhaps due to the small sample size), the results of the analysis that controlled for implicit and explicit extraversion are interesting. Table 2 shows the correlations between all variables at pre and post-tests. Extraversion measures, at pre-test, are positively correlated with leadership outcomes. Dynamism and Dominance are positively correlated with some elements of transformational leadership: idealized influence attribute and behaviors, inspirational motivation and intellectual stimulation. These results are in line with the literature (Avolio & Bass, 2004; Judge & Bono, 2000). In both observations, transactional and transformational leadership are correlated with each other and with the outcomes. To assess whether the effects of the leadership training are moderated by inter-individual differences in extraversion (dynamism and dominance), we conducted a series of univariate analyses of covariance for repeated measures (RM GLM) on the MLQ measures.

All variables were standardized before the analysis. In order to clarify the nature of interaction effects, graphical representations are shown in Figures 1 and 2. A significant dynamism by observation (pre- vs post-test) interaction effect was observed on the dependent variable leadership outcomes, a measure of group success, $F_{(1, 42)} = 10.45$, $p = 0.002$, $\eta_p^2 = 0.20$. We observed that the gain in satisfaction and effectiveness (the "Outcome" MLQ scale) is more evident for students who are low in dynamism (Fig. 1a). We also observed a significant interaction effect on our measure of Laissez-faire leadership style, $F_{(1, 43)} = 4.20$, $p = 0.47$, $\eta_p^2 = 0.09$. Less dynamic people show a bigger reduction of Laissez-Faire leadership behaviors (Fig. 1b). Finally, we observed an interaction between the time of measurement (before and after the class) and implicit introversion on the dependent variable Individualized Consideration, a fundamental component of transformational leadership $F_{(1, 43)} = 5.24$, $p = 0.27$, $\eta_p^2 = 0.11$. People that are high in implicit introversion show an increase in their score at the Individualized Consideration measure. Students high in implicit extraversion did not show a clear uptrend (Fig. 2). Introverted students seem to learn to pay more attention to their collaborator's need for achievement and growth. Dominance increased after the workshop t(44) = -2.030, p = 0.048. Individual scores on the pre-test (M= 36.11, DS= 7.21) are lower than those at the post -test (M= 37.42, DS= 6.20).

Figure 1. Interaction effect. ±1 SD profile plots of Outcome measure (fig. 1a) and Laissez-Faire (fig. 1b) by observation (X axis) and dynamism (different lines).

Figure 1a. Outcome

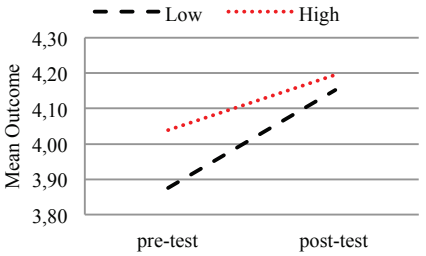
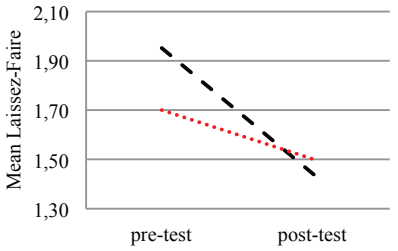


Figure 1b. Laissez-Faire.



4. Discussion

Taken together, these results suggest that the class was partially effective in changing students' perception of their effectiveness, their Laissez-Faire leadership styles, and their Individualized Consideration. Improvements in Laisse-Faire style, Individualized Consideration and in the perceived Outcomes of their leadership are conditioned by their introversion. Hence we can say that the level of dynamism declared by the subjects, namely energy, vitality, talkativeness, sociability and enthusiasm, interact significantly with satisfaction, sense of efficacy and the perception of being able to relate positively and motivate others, such that the class is effective only for those students that are low in extraversion.

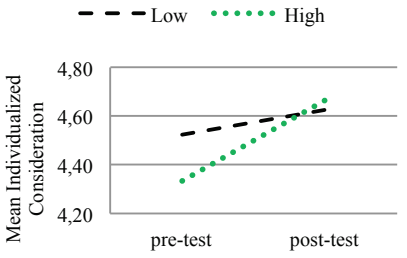
Following the simulation with vLeader, introverted subjects tend to feel more effective, able to motivate and to lead efficient groups; finally, they are more satisfied about their leadership. Dynamism is also a predictor of the Laissez-faire style, a passive approach to problem solving. Subjects declare that they have reduced avoidance behaviors after the training; they are more willing to make decisions and take responsibility, more ready to intervene without waiting for the aggravation of the problem. Implicit Extraversion moderates the effect of the simulator on Individualized Consideration, a key component of transformational leadership. The most introverted personalities show an increased score in individualized consideration. In detail, they declare to be more sensitive to other people's needs and tend to spend more time helping others to develop their aspiration. They consider their co-workers as individuals more than before taking the class, especially if they are more introverted. In addition, the graphical analysis of the profile plot seems to suggest that the strongest results have been achieved for people with more room for improvement. Indeed, in all three cases of moderation identified in this study, the means at the post-test for students high and low in extraversion are much closer than the means at the pre-test, suggesting that a ceiling effect has been observed for people that are high in extraversion.

This may suggest that the effect of the simulation depends on the starting level of the students. This dynamic seems particularly evident for the effects of the training simulator on Individualized Consideration: before the class, subjects with high and low implicit introversion showed quite different levels of Individualized Consideration. This difference seems to be reduced after having successfully completed the simulation.

4.1. Limits and Conclusion

A limitation of this research is represented by the use of a small and specific sample. Also, we did not have the chance to assess changes in a control group. This does not exclude that the observed changes in leadership behaviors are related to other dimensions of experience, such as university education or professional events occurred at the time of the workshop. We observed a lack in internal-consistency for some of the MLQ scales. It will be necessary in future investigations to invest time in a detailed localization of these scales. Furthermore, we observed a ceiling effect for many MLQ scales: at the pre-test, scores are often located at the higher ends of the scales. This decreased the likelihood of observing changes. A way to address this limitation may be to further investigate the performance of subjects with the information recorded by the simulation. This data could be very useful to assess whether simulations can change behaviors controlled by self-perception and personality. There are individual characteristics that we do not control, but play an important role during training. For example, self-efficacy leads to better learning (Bandura, 1994; Phan, 2011), goal orientation and motivation influence training outcomes. Indeed immersion, a subjective perception of realism (Salas, 2009), could mediate the degree of permeability and openness to change behaviors. Hence, it would be useful to control for these variables to better understand the learning process. Finally, we employed only self-reported measures of leadership rather than assessments of leadership coming from followers or collaborators of the leader, hence our study may be affected from single-source bias. We had to employ this approach because many students do not work and those who work do not yet hold leadership positions. It is nonetheless important to run multi-source studies on bigger samples with a control group before these results can be considered definitive.

Figure 2.
Interaction effect. Profile plot of Individualized Consideration, by session (X axis) and introverted profile (different lines). Different lines represent group of subject scored above and below one standard deviation from the mean Implicit introversion.



Simulations can represent an innovative training solution, effective for specific samples of population. In our case, female students who have benefited more from the use of the simulation, showing behaviors in line with the objectives (of the training simulation) and learning over time, are the most introverted and the least dynamic of the group. The characteristics of the simulation may have favored this effect, the limits to the action of players may have been an obstacle for those most dynamic and skilled in managing interpersonal relationships outside the virtual reality. Extraversion and Conscientiousness have already proven to be good predictors of learning (Barrick & Mount, 1991). Extraversion, in particular, is a good predictor of the training performance for different professional categories (*ibidem*). Investigating aspects of personality that may interfere with or facilitate the learning processes initiated by serious educational games would allow us to identify the strengths and weaknesses of these depending on the type of class to be trained.

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