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TO PLAY, OR NOT TO PLAY: BUILDING A LEARNING ENVIRONMENT THROUGH COMPUTER SIMULATIONS

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Abstract

This article analyzes the impact of a computer simulation (business game) on the users' perceived learning. The theoretical model developed in this paper is derived from the collaborative learning and the Human-Computer Interaction assumptions. The hypotheses relating groups' dynamics and the user-computer interface design with the users' perceived learning are tested using the business game "FirmReality", on an 89 respondents sample. Multiple regression and qualitative results show that, in a computer based simulation context, perceived learning is more influenced by human-computer interaction factors rather than groups dynamics.

Keywords: collaborative learning, virtual learning environment, business games, HCI.

1   INTRODUCTION

Business games are often defined as the new frontier of adults' learning. Notwithstanding the wide interest generated by business games, many calls have still to be addressed on the design and utilization side.

Managerial business games are a fertile soil for experimentation. If compared with paper-based case histories, they could be less consolidated in terms of design methodologies, usage suggestions and results measurement. The aim of this article is to collect empirical evidences, both qualitative and quantitative, on the design and the utilization side of a computer based business game.

In the last few years, a positive trend in business games adoption could be easily seen in the undergraduate and graduate education field. The growing interest about *Virtual Learning Environment* (VLE), and, consequentially, about business games can be traced back to two main factors. On the one hand, there is an increasing request of non-traditional education, side by side with an education model based on class teaching (Alavi and Leidner, 2001). On the other hand, the rapid development of Information Technologies has made available specific technologies built around learning development needs (Webster and Hackley, 1997; Alavi and Leidner, 2001).

Business game use in a learning context is based on the following assumption: an interactive approach leads to a more effective learning process and outcome (Gorrel and Downing, 1989; Torney-Purta, 1993). The adoption of a business game to be played in groups is based, moreover, on the complementary assumptions of collaborative learning (Johnson and Johnson, 1975).

This paper considers a business game, played in groups, which reproduces the linkage between organizational capabilities and the competitive advantage of the firm (Pfeffer, 1998, 2000). In particular, this study analyzes the weight and the importance of group dynamics and technological interface facets on the player's perceived learning. Figure 1 shows the underlying scheme of this article. Each of the three variables (*collaborative learning*, group processes and HCI) will be subdivided in the basic variables needed to understand the impact of a business game on users' perceived learning.

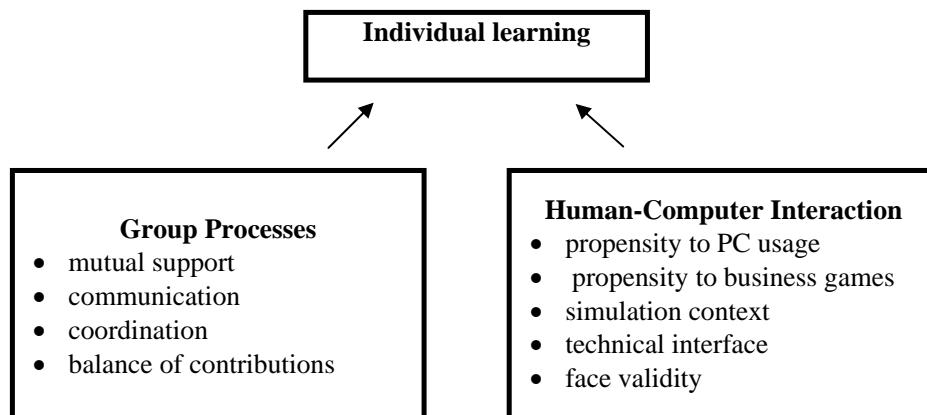*Figure 1:   business game variables related to individual learning*

Moreover, this article wants to offer a contribution in the area of business game design and use, in order to maximize the effectiveness of this learning tool and the investments needed to implement it into practice. We underline the role of the user-computer interaction to explain a significant part of the users' perceived learning.

2   REQUIREMENTS FOR EFFECTIVE LEARNING

Design and use of a business game have to be strictly connected with the theoretical instruments available to read the learning process. From extant literature it is possible to highlight three different perspectives that lead to an effective learning process (Alavi, 1994; Alavi et al., 1995): a) active participants involvement, b) group orientation, c) problem solving.

a) Cognitive theories consider learning as an active and constructive process made by the user (Shuell, 1986). From this point of view, learning is better developed through individual involvement in the knowing process, with the acquisition, generation, analysis and elaboration of information.

b) Vygotsky (1978) states that learning is a social activity, initially shared by individuals, and then internalized and personalized by each individual. This theory is supported by a number of empirical researches (Brown and Palincsar, 1989). In a context of collaborative learning, through discussion, conversation and comparison, participants develop interpretations and solutions of the proposed problem solving situation. These dynamics lead to a better knowledge development and interiorization.

c) Research shows that knowledge of the general problem solving strategies is acquired through practical resolution of complex problems (Pellegrino and Glaser, 1982; Resnick and Glaser, 1976).

The three perspectives are analyzed by Johnson e Johnson (1989) and integrated upon the very well known label of *collaborative learning*.

3   THEORETICAL FRAMEWORK

The previously cited characteristics are a necessary requirement to have an effective learning, even if they are not specifically designed to analyze learning processes mediated through technology. This paper refers to collaborative learning contexts mediated through IT, called in the literature *Virtual Learning Environments* (VLE) (Wilson, 1996). It is a diffused thought that beside the collaborative dimension, it is necessary to consider the aspects related with the relation between user and the adopted technology (Piccoli, Ahmed and Ives, 2001).

3.1   Group processes in a collaborative learning environment

Many studies have shown that a positive climate among subjects is fundamental to improve the productivity of their learning process (Alavi et al., 1995). Thus, group dynamics have a strong impact on learning results within a team based context, such as collaborative learning environment.

For example, Hoegl and Gemuenden (2001), starting from the assumption that team performance depends on how members collaborate or interact, have proposed and validated the *teamwork quality* (TWQ) construct, which components can be used as relevant measures to evaluate the quality of relations among group members' and individual learning. Other authors have shown the relationship between relational aspects and group effectiveness from other perspectives: numerous studies analyze the linkage between group performance and cohesion (Mullen and Copper, 1994, Zaccaro and McCoy, 1988), communication (Shaw, 1981; McGrath, 1984) and interpersonal ties (Likert, 1961; Kiesler et al., 1984).

Group relational dynamics are even more important when the group is asked to solve tasks that require information exchange and social interaction (Wagner, 1995; Gladstein, 1984). Social relations impact is deeper when the task to be solved is complex and characterized by sequential or reciprocal interdependencies among members (Thompson, 1967).

3.2   The Human Computer Interaction (HCI)

Virtual environments are often described as proficient learning tools (Kalawsky, Bee and Nee, 1999). Despite the potentiality, as stressed by Eggleston e Janson (1997), Stytz (1996) and Kalawsky (1993), there is the need for an in-depth analysis of relationship between user and computer. *Naïve* business games (not designed by professionals) can hinder the global performance of a simulation and bring to negative effects on the learning side. For these reasons the technological facets are considered a fundamental issue for a proficient relationship between user and computer in order to improve the learning process effectiveness (Alavi and Leidner, 2001; Leidner and Jarvenpaa, 1995; Hilbert and Redmiles, 2000).

4   CONSTRUCT AND HYPOTHESES

The literature review has led us to the selection of the fundamental variables to analyze group dynamics and the main technical facets (HCI) of a computer simulation. These are: mutual support, communication, coordination, balance of contributions, cohesion, propensity to PC usage, propensity to business games, simulation context, technical interface and face validity.

4.1   Mutual Support

Competitive behaviours inside a team determine distrust and frustration, while reciprocal support helps the integration of the members' competencies, leading to an increased quality in the solutions developed by the group. Cooperative and mutually supporting behaviours, considered as the contribution of each member's effort to the completion of an interdependent task, lead to a better team effectiveness (Tjosvold, 1984; Wagner, 1995).

Hypothesis 1: mutual support is positively related to perceived learning of individuals.

4.2   Communication

Communication is the way by which group's members exchange information (Pinto and Pinto, 1990). The importance of communication inside the group is highlighted by Shaw (1981), stating that good group functioning is linked with communication easiness and efficacy among members.

Moreover, individuals should be granted of a communication openness environment. A lack of openness should negatively influence the integration of knowledge and group members' experiences (Gladstein, 1984; Pinto and Pinto, 1990). These statements are confirmed by several empirical studies, showing direct and strong correlation between communication and information flows and group performance (Griffin e Hauser, 1992; Gemuenden e Lechler, 1997).

Hypothesis 2: communication is positively related to perceived learning of individuals.

4.3   Balance of contributions

Each member, during the decision process, brings to the group a basket of knowledge and experiences that allows the group to develop a cognitive advantage over individual decision process. Thus, it is necessary that each member brings his/her contributions to the group (Hackman, 1987; Seers et al., 1995; Grandori, 1995).

Empirical studies confirmed the direct relation among balance of contributions, performance, learning and satisfaction of team members (Seers, 1989).

Hypothesis 3: the balance of members' contribution is positively related to perceived learning of individuals.

4.4   Coordination

A group can be seen as a complex entity integrating the various competencies requested to successfully solve a complex task. For this reason, a good balance of members' contribution is a necessary condition, although not sufficient. The expression of the group cognitive advantage is strictly tied to harmony and synchronicity of members' contribution, i.e. the degree in which they coordinate their individual activities (Tannenbaum et al. 1992).

Hypothesis 4: coordination is positively related to perceived learning of individuals.

4.5   Propensity to PC usage

Attitude toward using PC can be defined as the user's overall affective reaction to using a PC (Venkatesh, 2003). The Propensity to PC usage can be traced back to the concepts of pleasure, joy, interest associated to the technology usage (Compeau and Higgins 1995b; Compeau et al., 1999). It is consistent to accept that user characteristics have an influence on the user interface perception. Many researches (i.e.Goodhue e Thompson, 1995, Venkatesh et al., 2003) point out that attitude towards computer use could influence their use involvement, increasing or decreasing the impact of simulation on learning process.

Hypothesis 5: propensity to PC usage is positively related to perceived learning of individuals.

4.6   Propensity to business game usage

Based on Triandis (1977) definition of attitude, propensity to business game usage can be defined as the cognitive and affective elements that bring the user to assume positive/negative behaviors in a business game environment. In fact, in such kind of situations the user can develop feelings of joy, elation, pleasure, depression, or displeasure. (Davis et al. 1989; Fishbein and Ajzen 1975; Taylor and Todd 1995a, 1995b).

Hypothesis 6: propensity to business game usage is positively related to perceived learning of individuals.

4.7   Simulative context

The simulative context can be traced back to the role assumed by individuals during the simulation. In particular, this concept is referred to the role of participants, teachers and their relationship. Theory and practice point out that business games have to be self-explaining. In other words, the intervention of other users or the explanations of teacher to explain the simulation dynamics have to be limited in a specific timeline. Otherwise, the user effort to understand the technical and interface features of the simulation could have a negative influence on learning objectives (Whicker and Sigelman, 1991).

Hypothesis 7: simulative context is positively related to perceived learning of individuals.

4.8   Technical interface

Technical interface can be defined as the way information is presented on the screen (Lindgaard, 1994). In a business game, the interface concept is also referable to the interactivity facet (Webster e Hackley, 1997; Alavi e Leidner, 2001). A bourgeon number of studies has pointed out the influence of technical interface on user performance and learning (Jarvenpaa, 1989; Lim, et al., 1996; Todd and Benbasat, 1991).

Hypothesis 8: perceived quality of the technical interface is positively related to perceived learning of individuals..

4.9   Face validity

The face validity defines the coherence of simulation behaviours in relation with the user's expectancies on perceived realism. It is also possible to point out that the perceived soundness of the simulation is a primary concept concerning the user perceived learning (Whicker e Sigelman, 1991). The simulation cannot react randomly to the user stimulus, but it should recreate a certain logic path which starts from player action and finishes with the simulation reaction. Since that, we suppose that the level of face validity can influence the learning process.

Hypothesis 9: simulation face validity is positively related to perceived learning of individuals.

5   THE BUSINESS GAME

FirmReality is a business game representing the dynamics of a start-up firm in the mobile phone industry, with approximately 800 employees. Users play the specific role of the top management team in a telecommunication firm with strong needs of growth and formalization, while maintaining a high level of internal motivation and customer satisfaction. The main goal is to obtain competitive advantage in terms of above-average income and above-average customer growth (Pfeffer, 1998, 2000). Players can monitor firm performance through several indicators, in a balanced-scorecard fashion (Kaplan and Norton, 1992).

FirmReality is played in groups of 5 people and the game results are not attributable to individuals but to the whole 5 people group. The reason of a group game holds in the collaborative learning environment necessary to build a context for effective learning (Johnson and Johnson, 1975).

6   METHODS

6.1   Experimental Context

Data has been collected through an experiment involving 90 individuals, divided into 18 groups. The experiment was held on undergraduate students at Bocconi University[1].

Groups were not created by instructors but self-selected, with the 5 people per group constraint. None of them had had previous experience with this computer simulation. Every group conducted the simulation in front of a PC where the game was running. The experiment involved 90 participants for a period of 80 minutes (the standard time span designed ex-ante for FirmReality), preceded and followed by a briefing and a debriefing conducted by the instructors (total experiment time: 200 minutes).

At the beginning of the simulated scenario all players received introductory information referred to: firm strategic position, goals to reach, time available, actions to be used to reach the goal. After 40 minutes, half the simulation time, the game stopped to give participants the possibility to discuss the planned and the emergent strategy. To help the discussion, a form with standard question was provided by instructors. At the end of the simulation, a similar form was provided to analyze the final results and compare them with the strategy and the actions taken.

Quantitative data has been collected through a questionnaire at the end of the final debriefing session. Questionnaires were compiled on a voluntary and anonymous basis. The number of respondents was 89 (99% of the individuals participating to the simulation).

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[1] No quantitative data are available from a managerial sample. The simulation has been repeatedly used with managers from various companies and hierarchical levels, showing behaviours very similar to these reported in the qualitative section of this paper.

Qualitative data was gathered for data triangulation. During the briefing session, the simulation and the debriefing authors collected data with direct observation of groups' and individuals' behaviours. Every observation was formalized, codified in a file, read several times, discussed with an external referee and then grouped according to the variables of the quantitative model (as suggested by Myers and Avison, 2002).

6.2   Measures and Analysis

Data were gathered through individual data collection sessions using a fully standardized questionnaire (five-point answer scale). The data collection session was conducted in the same room, assuring similar conditions for every respondent. The scales used to assess the variables show acceptable reliabilities (Cronbach's alpha): the alpha value is always above 0,7 except for three variables, simulation context, face validity and coordination, showing an alpha value ranging between 0,6 and 0,66.

Table 1 provides an overview of the variables in terms of descriptives, reliability analysis and correlations.

To test the hypotheses, we conducted multiple regression analyses using individual perceived learning as the dependent variable, groups' dynamics and technical facets as independent variables. Table 2 reports the results of the regression analysis. The regression model shows a good linear fit (adjusted R^2= .483).

7   RESULTS

The results of the regression model provide support for the general statement of our research: perceived individual learning is influenced more by technical factors than groups' behaviours. A good integration of results is obtained through the comparison between quantitative and qualitative data.

Hypothesis 1 states that group members' mutual support is favourable to individual perceived learning. Regression results do not support the hypothesis, showing the existence of an opposite relation (beta= - .239; p<.10). Analyses show that the higher is the mutual support, the lower the perceived learning. Qualitative observations made by the authors on simulating individuals indicate some possible reasons for this result. Mutual support among members has been seen has an interference between user and simulation. If the business game is self-explanatory (as FirmReality), every discussion among users on simulation interpretation will not give any added value to participants. These relations lower users' concentration and become obstacles in the goal achievement path. Furthermore, this statement is strongly related with group effectiveness theories: high time pressure on group brings to ineffective decisional process. Thus, each element not related with the group task is perceived as loss of time from the problem solving process.

Here are reported some conversation examples among members.

"I don't have too much time to share with you; I'm loosing my understanding of the situation", "Attention, please, we lost the computer message. Do not keep stopping my reading, even if you don't understand".

These communication excerpts show that attempts to help one each other can hinder the comprehension of some phenomena emerging in the simulation.

Hypothesis 2, the higher the communication quality the higher the individual learning, is supported by the regression analysis (beta= .205; p<.10). Qualitative data also support this hypothesis. Authors observed that groups with a good communication process participate to the debriefing session with higher quality observations.

"If I do restructure the organization through a divisional solution, while using actions sustaining motivation, I'll have a less problematic change process".

Hypothesis 3 is strongly supported both qualitatively and quantitatively (beta= .197; p<.10). From forms filled by users it was observed that groups with balanced contributions have developed better strategies and game solutions.

Hypothesis 4 is not supported by quantitative data. Qualitative data tell a different story: individuals belonging to groups with a better coordination level show a better intervention in the debriefing phase. They also offer good hints to deepen the topics included in the simulation.

"We initially discussed and shared strategy within the group. This greatly helped us understand what was going on", "When possible, we divided among us the observation of the different facets of the game, but, it was not useful".

Hypothesis 5 is not supported by regression results. The reason for this result holds in the simulation easiness of use. FirmReality interface is straightforward and does not impact on the perceived learning because it is seen as non influential by users. On the contrary, a complex simulation could lead to a worsening in individual perceived learning, because the cognitive effort of the participant can be deviated from the underlying theories to a cumbersome interface.

"This simulation is easy, just a mouse click and nothing more".

Hypothesis 6 is strongly supported (beta= .438, p< .01). Propensity to simulation use is one of the elements in the model with a higher explanatory power on individual perceived learning.

Hypothesis 7 is not supported. Moreover, quantitative analyses show an inverse relation compared with the statement contained in the hypothesis: the higher the simulation context quality, the lower the perceived learning (beta= -.155; p<.10). As stated before, this result could also be explained through the self-explication of the simulation. It is possible to argue that good instructions and quick suggestions during a paper based case history analysis can help in generating users' commitment and perceived learning. A self explanatory simulation brings users to consider the intervention of the teacher as an interruption rather than a suggestion. It is known that simulations have an impact on the learning process through the reception step (Alavi and Leidner, 2001), meaning that teacher's or other members' intervention hinder participants to understand incoming information.

[Instructor] "Everything ok?"

[User, quick and sharp] "Yes, yes, ok"

[Instructor] "Help needed?"

[User] "No, thanks"

[Voice within the group] "Come back, our company is close to bankruptcy"

Hypothesis 8, related with interface influence on perceived learning, is strongly supported by the regression model (beta= .318; p< .01).

Hypothesis 9 predicts that the higher the face validity, the higher the perceived learning. This hypothesis is not supported by quantitative results. Qualitative data show a strong coherence between simulation reactions to users' actions and users' expectancies about a standard behaviour of the company described in the game.

"What was I saying? If you act just on the soft side, performance will take a nose dive!!"

"You are still persuaded that benefits like bonus travels are positively impacting motivation... This is ridiculous..."

Variables	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10
1 propensity to IT use	27.73	5.01	(.81)									
2 propensity to business games	24.39	4.61	.188	(.81)								
3 simulation context	21.46	3.90	.098	.222***	(.60)							
4 face validity	40.21	5.70	.167	.427***	.462	(.66)						
5 technical interface	25.24	4.42	.060	.472***	.210**	.537***	(.73)					
6 perceived learning	16.52	2.80	.156	.616***	.088	.427***	.569***	(.76)				
7 balance of contributions	27.67	4.68	-.016	.320***	.048	.244**	.268**	.288***	(.71)			
8 communication	44.42	7.12	.147	.435***	.309***	.324***	.290***	.332***	.455***	(.79)		
9 coordination	21.75	3.46	.060	.489***	.231**	.300***	.343***	.277***	.577***	.646***	(.63)	
10 mutual support	35.51	5.52	.031	.355***	.101	.272***	.247**	.201	.724***	.659***	.681***	(.84)

*Table 1: descriptives, correlations and reliability analysis (Cronbach's alphas are in parentheses). N=89; ** p<.05; ***p<.01*

Independent variables	Dependent Variable: **Perceived Learning**
mutual support	- 0.239*
communication	0.205*
balance of contributions	0.197*
coordination	- 0.134
propensity to IT use	0.04
propensity to business games	0.438***
simulation context	-0.155*
technical interface	0.318***
face validity	0.125
Adjusted R^2	*0.483*

*Table 2: linear regression model results: impact of independent variables on perceived learning.. N=89; * p<.1; ** p<.05;***p<.01;*

8   DISCUSSION AND CONCLUSIONS

Previous researches have shown the importance of involvement and participation in the fields of standard face-to-face education and in distance learning environments (Webster e Hackley, 1997). This paper supports the validity of these previous statements, extending them to the computer simulation field. Quantitative analysis results suggest a relevant impact on perceived learning of the two types of variables used in this paper: group dynamics and human-computer interaction. In particular, the "game" dimension seems to capture the most part of participants' cognitive energies. These energies are deviated from the standard group behaviour, causing peculiarities in the empirical evidences, explainable through qualitative observations. Results, both quantitative and qualitative, lead to a stringent *fil rouge*. Despite the fact that the simulation is computer based, data do not show the emergence of a strong need for computer proficiency. Our conclusions are consistent with other researches which showed the impact of the easiness of use on individual performance and learning (Delone and McLean, 1992).

The opposite is true regarding attitude towards business game in a learning environment. This result is consistent with Kolb's theory (Kolb, 1984) about individual different learning styles.

The relationship between user and machine is mediated by the interface deigned for the simulation, probably the main variable to explain and favor the learning process. Both qualitative and quantitative results show a good support to the view of business games as high involvement learning tools. Thus, user's attention is captured by the interface (if correctly designed as in the case shown). Context information disturbs players, which are concentrated on the simulation. Time pressure, propelled by the business game, is high enough to penalize further information provided by instructors and group members during the game. This explains the quantitative results concerning the hypotheses related with mutual support and simulative context. Learning computer simulations seem to have their major strength in the computer interaction, which ought to be the main focus in the design phase of the game. Interaction among groups' members is still important, but less relevant than the interface on the individual perceived learning. The reason could stand in the individual necessity to absorb several information contained in the business game. Instead, the aim to solve strategic problems and to decide which moves have to be taken in order to reach the simulation goals is left to the discussion phase. The group interaction can have a positive impact on people involvement even if less important than technical interface. Furthermore, from a managerial point of view, the design of group simulations allow the reduction of expenses for needed technological infrastructures.

Finally, we can consider the business game as a effective tool for learning development. In fact, through the adoption of a business game, it is possible to develop capabilities which are difficult to learn through traditional lessons. This positive impact is due to the ability of business game to stimulate, not only the meaning of the theoretical concept, but also the logical relationship among them.

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