**Cibopolis: a serious game based on socio-constructivist learning approach**

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**Abstract**

*The theoretical framework*

The theoretical assumptions of game-based learning are different from those of traditional instruction. The academic literature proposes that digital Game-Based Learning Environments (GBLEs) may be considered as the new media for learning and teaching (Pannese & Carlesi, 2007). Indeed, digital GBLEs are able to grasp new and integrated forms of experiential, social, constructivist, and situated learning, which both exploit the potential of Information and Communication Technologies and allow a diverse way of experiential learning and training, too (Hetzner & Pannese, 2009).

As with nearly every innovation, a critical issue with the integrated learning processes – such as social, experiential, constructivist, and situated ones – for instructional design emerges (Jonassen & Rohrer-Murphy, 1999). Thus, while detailed conceptions and prototypical game-based learning solutions exist, the way to perform the analysis phase of the design and development process for game-based learning environments remains relatively explored. We sustain that the methods of needs and task analysis are not appropriate for designing GBLEs, here conceived as computer-supported collaborative learning environments. Indeed, such classical methods assume that relevant knowledge may be embedded in the instruction for transfer to the learner in any context. This is in contrast with the assumptions of the new trends of learning and teaching processes, which put learners at the center of the learning experience, changing their position from passive cognitive containers to active participants and real actors of their learning path (Pontecorvo, 2004; Scardamalia & Bereiter, 2005).

Actually, the scholars of socio-constructivist framework of learning contribute to reformulate learning and knowledge creation as social processes, constructed in the space and time of social interaction. Therefore, it seeks to balance individual agency with the sense of belonging to a community, going beyond the traditional

conception of knowledge and learning in the mind-box. Coherently, they suggest that the social interaction could support the collaborative construction of concrete learning outcomes – such as, a paper, a learning object, a game dynamics, and so on –. Moreover, they stress the importance of mediational tools that aim to support active and self-regulated learners in a meaningful learning process. Then, they highlight the importance given to complex skills, such as metacognition and critical reflection, collaboration and problem solving.

The main points above discussed could be essential for designing game-based learning solutions, which are activity-oriented, cognitively distributed, and intersubjective goal-oriented tools.

Within the framework yet described, we should be able to evaluate the efficacy of the prototype Cibopolis, a game-based learning environment, designed coherently with the socio-constructivist framework and developed to support healthy promotion and nutrition education. Especially, Cibopolis as case study is able to grasp different learning processes, involving learners as players in collaborative participation and knowledge building on nutrition and healthy lifestyle.

*Case study: the serious game Cibopolis*

Cibopolis (Cibus=Food and Polis=City) is a digital serious game aims at educating on nutrition and healthy lifestyle. The prototype of Cibopolis was designed and developed during the Research & Development project named 'Healthy Promotion Living lab through alternate reality game' (HELP LARGE – www.helplarge.com), funded by Regione Puglia and managed by Grifo multimedia S.r.l. (IT) with the scientific supervision of the physicians from the Department of emergency and organ transplantation, University of Bari.

At the start of the game, learners are introduced to the game, the tasks, the tools to be used and the objective of the game, that is, to gain citizenship in the city of Cibopolis via achievement of the '5 daily meals' cups'. The '5 daily meals' cups' has been designed according to the knowledge about the Mediterranean nutrition. Learners have to compose their daily Mediterranean meals following some relevant steps: first, they have to fill the pantry of their house, buying the proper foods for every meal in the virtual market. Then, they can organize their meals selecting in the pantry the correct foods able to make a healthy meal.

To do the shopping, learners can use the coins of Cibopolis 'Cib€uri'. Whether learners spend all the Cib€uri, they can obtain other coins in different ways. First, they may enhance social networking and share knowledge writing recipes in the virtual repository 'Ciblioteca'. Second, they may complete healthy missions about nutrition and physical activities in the real world, then documenting their process/outcome in the virtual forum 'Mission'. Then, they may create new missions about nutrition and physical activities in the virtual forum, so enhancing competition as well as collaboration between learners in game.

Such missions – both documented and created – are monitored by a committee of social and health experts (i.e., physicians, nutritionists, dietitians, psychologists) from the University of Bari that evaluate the learners' posts in the virtual forums thus authorizing their online publication.

Cibopolis is divided into five areas, in which different dynamics about nutrition/healthy lifestyle and learning processes are addressed:

(1) House. Learners may create their personal and humanized avatar and play the mini-game '5 daily meals' cups' in this area. Moreover, the house introduces learners in the space of social networking, too.

(2) Market. Learners may buy the proper foods for composing their daily Mediterranean meals. It supports the game logic of '5 daily meals' cups'.

(3) Municibio. Learners may choose the missions about nutrition, participate to the social networking activities in the blog and forum spaces. Moreover, every learners may view the top of the player ranking.

(4) Gym. Learners may select the missions about physical activities, so documenting them in the specific forum.

(5) Ciblioteca. This is the online repository and knowledge building space. Indeed, learners may download here the contents about nutrition, wellness and healthy lifestyle uploading by the committee of social and health experts; moreover, learners may share their Mediterranean recipe in the specific forum 'Recipes'.

Going beyond the specific areas above described, Cibopolis has been designed to support the dynamics of social networking. Indeed, learners may follow the other members of the Cibopolis community; moreover, they may comment the posts of their follower and following and put a 'like' to their posts.

Thus, gameplay and social dynamics are strictly interwoven in Cibopolis. Indeed, learners have to achieve the '5 daily meals' cups', doing shopping and spending Cib€uri. When the coins are not enough, learners can obtain other Cib€uri through the participation to the social life; in short, they may post Mediterranean recipes; moreover, learners may document their missions about nutrition and lifestyle; then, they may post notes in the community's blog and forums. Briefly, all these activities give learners the possibility to earn money and points, so contributing to the conjunction of the game and social dynamics.

Concisely, with the help of the Internet, smart phone and tablets, Cibopolis becomes a ubiquitous GBLE about nutrition and physical activities able to merge the real and virtual worlds as well. Moreover, Cibopolis has been designed and developed to support and foster experiential and social learning processes, metacognition, problem solving skills and knowledge building development in the informal community of practice about nutrition and healthy lifestyle.

*Pilot test: analyses, main results and conclusions*

Consistent with the general objective of the present study that was to enhance insight into the deep relationship between the socio-constructivist learning framework and the digital serious game design, hypotheses regarding the learners' perception of the digital serious game Cibopolis were formulated.

According to the user-centric evaluation framework for recommender systems (Pu et al., 2011), we suspected that a unified evaluation framework is required. This may help in exploring, on the one hand, whether and how the serious game Cibopolis may modify the learners' behaviors concerning healthy lifestyle; on the other hand, whereas such an evaluation model could reinforce a preliminary assessment about the effectiveness of the serious game in changing learner attitudes and behaviors about nutrition and healthy lifestyle.

Thus, we tested the relationships between the Cibopolis' system qualities, the game's perception, and the correlated learners' attitudes. More specifically, we first hypothesized that the qualities of the system Cibopolis, as the multimedia and structural adequacy, the clarity of objectives, positively affected the perception of the serious game. Second, we hypothesized that the learners' perception of the serious game Cibopolis significantly influenced their attitudes, which in turn affected their behavioral intentions. Figure 1 gives a view of the hypotheses described.

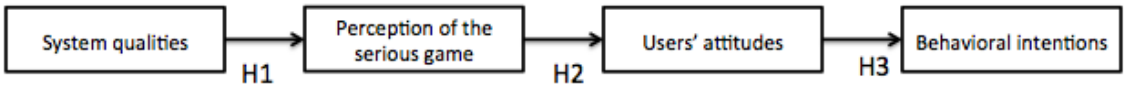


Figure 1 – Hypotheses scheme

People (N=65), who ranged in age from 14-32 years old, were involved in the study.

After using Cibopolis, learners filled in a questionnaire, composed of a scale ad hoc built. Indeed, items on the effect of the system on the learner attitudes and behaviors were formulated ad hoc.

Specifically, the construct definition of System quality was built based on the system usability conceptions (Lewis & Sauro, 2009). The perception of the serious game Cibopolis items were inspired by recent studies on the subject of serious games evaluation. Within Poels and colleagues (2007), we considered the following components in building the questionnaire: enjoyment, flow, negative affect (disappointment, frustration), control (autonomy, power, freedom of expression), social presence (leader board, cooperation), competence (pride, personal improvements, engagements, achieved goals).

The constructs and the related items are reported in the Table 1. Then, the items on the learners' attitudes were introduced ad hoc.

The data collected was elaborated with a path analysis after considering the reliability of the scales constructed.

Consistent with the main results, internal reliability of the constructs was calculated. Internal reliability indices of the sub-scales are shown in Table 1.

| | *Cronbach's α* | Item-correlation |
|---|---|---|
| **System qualities** | | |
| *Ease of use* | 0.755 | |
| The game can be simplified | | 0.604 |
| The game needs to be improved | | 0.452 |
| I think I need a technical support to use the game | | 0.673 |
| I quickly familiarized with the game | | 0.526 |
| The game is difficult | | 0.460 |
| *Multimedia adequacy* | 0.778 | |
| The graphic of the game is appropriate | | 0.756 |
| The sound effects of the game are appropriate | | 0.506 |
| The game is very interactive | | 0.611 |
| *Structural adequacy* | 0.454 | |

| | | |
|---|---|---|
| The different functions of the game are well integrated | | 0.316 |
| The game was well structured | | 0.316 |
| *Clarity of objectives and control* | 0.740 | |
| I knew what to do in the game | | 0.587 |
| I knew what to do to win the game | | 0.587 |
| I had a perfect control of my character in the game | | |
| **Perception of the serious game** | | |
| *Enjoyment* | 0.573 | |
| The game was as I expected | | 0.269 |
| I was comfortable while playing | | 0.439 |
| I enjoyed playing | | 0.475 |
| The games make you feel you want to play continuously | | 0.300 |
| *Behavior in the game* | 0.532 | |
| I will frequently play | | 0.293 |
| I would like to play again | | 0.325 |
| I will talk to my friends about this game | | 0.422 |
| *Flow* | 0.767 | |
| I did not realize how much time passed while playing | | 0.624 |
| I was immersed in the game | | 0.624 |
| *Presence of social aspects* | 0.825 | |
| I felt represented by the avatar I created | | 0.252 |
| I like the way I can express myself in the game | | 0.713 |
| I like the possibility to customize my personal profile | | 0.754 |
| I like the possibility to add friends in the game | | 0.680 |
| I like the possibility to cooperate to reach the objectives of the game | | 0.638 |
| Missions are a good way to show what I am doing to friends | | 0.600 |
| **Users' attitudes** | | |
| *Users' attitudes* | 0.839 | |
| The game increases my awareness on nutrition | | 0.745 |
| The game increases my notions on nutrition | | 0.801 |
| I will check in a better way the composition of my meals | | 0.572 |

Table 1 – Constructs and internal reliability

Then, the relationships of the constructs were measured through the path analysis.

The results showed that there was a significant relationship between the serious game Cibopolis and the learner attitudes and behaviors of nutrition and healthy lifestyle. To sum up, Figure 2 shows the results of the path analysis, useful to examine the significance of the paths associated with these variables.

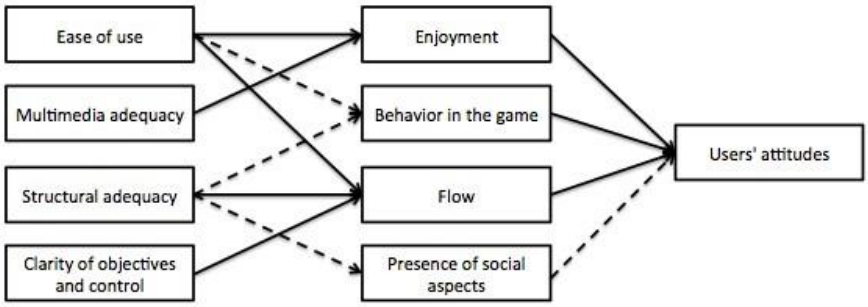


Fig. 2 – The path analysis model

To conclude, the findings of the present study allowed us at pointing out that the epistemic assumptions on socio-constructivist learning framework and the operationalization of game-based learning environments impacts on learner attitudes and behaviors provide useful support for IT professionals interested in designing game-based learning solutions as motivational, collaboration and instructional tools (Norradin & Kian, 2015). Especially, we claim that the integration of computer mediated and face-to-face communication could be strongly implemented in educational contexts to create game-based learning communities that improve learning processes through collaborative participation to socio-educational activities. We acknowledge that further analysis is needed to have a better model-fit increasing the size of the considered sample. Moreover, by using the proposed model, future work will be oriented in the development of a run-time user-profiling application to develop adaptive game frameworks able to support meaningful learning processes.

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