Je-LKS
Journal of e-Learning and Knowledge Society
The Italian e-Learning Association Journal
PEER REVIEWED PAPERS
GAMIFICATION AND SERIOUS GAME FOR LEARNING
Vol. 11, n.3, 2015
ISSN: 1826-6223 | eISSN: 1971-8829

SOCIAL, CONSTRUCTIVIST AND INFORMAL LEARNING PROCESSES: TOGETHER ON THE EDGE FOR DESIGNING DIGITAL GAME-BASED LEARNING ENVIRONMENTS

Gianvito D'Aprile
Pierpaolo Di Bitonto
Roberta De Asmundis
Antonio Ulloa Severino

Grifo multimedia S.r.l.
g.daprile@grifomultimedia.it, p.dibitonto@grifomultimedia.it,
r.deasmundis@grifomultimedia.it, a.ulloa@grifomultimedia.it

Keywords: Game-based learning, social learning, constructivist learning, digital serious game, game design

The theoretical conceptions of game-based learning are different from those of traditional instruction. Indeed, the classical approaches of needs and task analysis seem to be not appropriate for designing digital serious games as computer-supported collaborative learning environments. This paper aimed at arguing that social, constructivist and informal learning processes provided accurate frameworks for analyzing needs, activities, and outcomes for designing digital serious games. After focusing on the epistemic assumptions of such theoretical frameworks, this paper described the digital serious game Cibopolis as case study, able to grasp different learning processes, involving players as learners in collaborative participation and knowledge building on nutrition and healthy lifestyle. Especially, the context, the training goal, the

for citations:
D'Aprile G., Di Bitonto P., De Asmundis R., Ulloa Severino A. (2015), *Social, constructivist and informal learning processes: Together on the edge for designing digital game-based learning environments,* Journal of e-Learning and Knowledge Society, v.11, n.3, 23-39. ISSN: 1826-6223, e-ISSN:1971-8829

adopted learning solutions and the main features of the designed Cibopolis game were specified. Then, the results of the pilot test involving young learners (N = 65; Range of Age = 14-32 years old) was briefly reported. Specifically, it was pointed out how learners perceived the Cibopolis game in term of usability and engagement. To conclude, some relevant theoretical issues concerning digital game-based learning environments and practical implications that could support IT professionals – such as, instructional designers, developers, web designers, and so on – were highlighted.

1 Introduction

In the middle of 1990, Computer-Supported Collaborative Learning emerged as a new paradigm in instructional technology, able to merge collaborative learning and psychosocial dynamics as central phenomena for educational activities (Koschmann, 1996). Such a paradigm seems to be a relevant mean for supporting the new trends of learning and teaching in the so-called Knowledge Society. Especially, some scholars (Norradin & Kian, 2015) have highlighted that educational contexts are needed for enhancements in three main areas, those are students' motivation, collaborative learning environment for supporting students' engagement, and the conventional instruction methods.

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 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. In this paper, we sustain that the methods of needs and task analysis are not appropriate for designing GBLEs. 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 (Scardamalia & Bereiter, 2005).

In this paper, we argue that socio-constructivist learning theories provide a powerful framework for designing GBLEs. Thus, overall, the significant research question is specifically: «What are the fundamental pillars of socio-

constructivist learning theories that may support the design of GBLEs as motivational, collaborative and instructional artifacts?».

Accordingly, the paper contains three main sections. In the first section, the epistemic assumptions of socio-constructivist learning theories are reviewed as the structural foundation of the study. Then, the conceptual description of how such assumptions may be used to design activities and settings of GBLEs are discussed. Within this theoretical development, in the second section the prototype of digital game-based solution Cibopolis as case study is described. Moreover, the results of Cibopolis's pilot testing is briefly discussed. Finally, in the last section, the practical implications and some limitations of the study are discussed.

2 Theoretical framework

2.1 Social, constructivist and informal learning processes toward GBLE design

Nowadays, learning professionals and educational organizations are invited to consider the way in which individuals learn to learn, rather than just dealing with the content and outcomes of learning (Quisumbing, 2005). Such a perspective implies an inevitable turning point in considering learners and learning processes. Indeed, individuals have to be conceived as actively approaching learning activities, building their own knowledge, and going beyond the boundaries of information and the acquisition of competences (Wenger, 1998).

Within socio-constructivist framework, learning is a complex process involving developmental changes of learners, strictly intertwined with the activities performed, the tools used, the interactional construction of knowledge, and individuals' learning conceptions. Obviously, all of these components play an important role in relation to learning behavior and the quality of the learning outcomes (Cole, 1996; Ligorio, 2010; Vermunt & Verloop, 1999).

Coherently, learning and human mind are far from being an act of gaining knowledge and acquiring concepts and an empty box to be filled with notions provided by an expert, or contained within sources featured by the special status of educational material, respectively. Rather, learning is a complex process of participation (Lave & Wenger, 1991), involving individual aspects as well as social and cultural dimensions. Briefly, learning is conceived as a process of becoming a member of a certain community, during which people – learners as well as experts – activate a relevant knowledge building process (Paavola & Hakkarainen, 2005; Scardamalia & Bereiter, 2005).

Therefore, learning may be conceived as a social process that is an intersubjective process among individuals (Matusov, 2001), who participate in a significant goal-directed and tool-mediated interaction (Lave & Wenger, *op. cit.*).

The socio-constructivist conception of learning inherits well-established psychosocial theories and model, such as:

- Activity Theory (Vygotsky, 1978), which posits that learning emerges from motivated activities during social interactions. Such social interactions are constantly mediated by artifacts, which influence the interaction of human activities, thus supporting the development of complex skills (such as, problem solving, collaboration, communication, and so on). The scholars of human computer interaction have emphasized the Vygotsky's notion of mediation, especially highlighting that «all human experience is shaped by the tools and sign systems we use» (Nardi, 1996, p. 6).
- Distributed Cognition, which focuses on cognitive processes as distributed across the members of a social group. As to say that social interactions structure the cognitive processes, which also involve the coordination between internal and external (material or environmental) structure, and the management of time to develop an intelligent course of action (Suchman, 1987). In this way, knowledge and learning may be conceptualized as situated processes, deeply rooted in computer-supported collaborative environments.
- Community of Practice (Wenger, 1998), which points out that learning happens when people can participate in cultural practices, crucial for the community. Therefore, learning is closely related to a growing sense of personal engagement in the practice, a common objective, and a set of constantly negotiated procedures, routines, and languages.

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

Actually, the models above described have numerous dimensions in common. First, they contribute to reformulate learning and knowledge creation as social processes, constructed in the space and time of social interaction; therefore, they seek 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, the models 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, the models stress the importance of mediational tools that aim to support active and self-regulated learners in a meaningful learning process. Then, another idea common to the theoretical approaches regards the importance given to complex skills, such as metacognition and critical reflection,

collaboration and problem solving.

2.2 Designing socio-constructivist GBLEs: is it possible?

Consistent with the theoretical assumptions of learning theories, Thomas and Brown (2007) have pointed out that game-based learning solutions enable the fundamental merging of play and learning that is quite different from what we have come to consider as standard pedagogical practice. Accordingly, GBLEs could be the mediational tools able to change the trend from the traditional paradigm of *learning about* to the new form of *learning to be*. That is, GBLEs could be the spaces in which learners are part of communities of practice and participate to the knowledge building processes and situated social interactions.

These concerns allow at rethinking the way through which GBLEs may be designed and developed, thus gaining educational objectives, fostering learning processes, motivating, and inspiring learners. Indeed, through digital GBLEs, learners are led in the understanding of specific problems and subjects, are invited to accomplish tasks, receive feedbacks and suggestions on how to improve their cognitive, social, and emotional skills, and metacognition as well (Kapp, 2012).

The first key of a serious game is to induce learning without fearing for failures. Immersed in a safe virtual environment, learners are free to experiment and learn from their decisions and mistakes. Moreover, serious games can catch attention relying on basic instincts as competition, interaction, and imagination. The goal of serious games is to create a virtual environment in which, by encountering and solving problems in the game world, the player learns skills and builds knowledge useful for problem solving in the real world (McDaniel *et al.*, 2010). It could be argued that several factors have to be considered during the design process of GBLEs, to enhance socio-constructivist learning during the use of serious games.

The main goal is the engagement and continual involvement of learners since these lead to meaningful learning path. Another important element has to be considered, that is competition, inserted with hierarchy, points, and rewards, depending on the learners' progresses in the game.

Game design scholars (Keller, 1987) convey that multiple factors have to be considered to enhancing learners' motivation in GBLEs. Within Keller (*Ibidem*), the first factor is 'attention', which concerns the game capacity able to involve learners in the game dynamics and contents continuously. Three elements are proposed to achieve this goal: (1) perception that attained with the use of examples, conflicts, incongruences, and surprising elements; (2) inquiry that is linked to the presence of questions and problems; (3) variability that

is the lever to maintain learners' attention by modifying methodologies and contents periodically.

Second, 'relevance' is important, too. It regards the object to be learned, which has to be goal-oriented, consistent, and somehow familiar to the learner or to his/her own skills. The simple introduction of a clear goal adds purpose, focus, and measurable outcomes in the game (Prensky, 2000). Moreover, relevance could be sustained with the game's metaphor that is storytelling, which becomes more and more familiar to them during the game experience (Kapp, 2012). Indeed, the storytelling should match the learners' interests, or they should feel that the storytelling is worth to be understood, is new but interesting, is in line with their skills and abilities. This can be achieved by the insertion of challenges, or competitions, and so by reward techniques.

The third factor is 'confidence' that is related to the learner's attitude and expectation to achieve success. Learners feel confident when they believe they are controlling their own success because of their skills and abilities, and thanks to the knowledge added by playing the game. Then, the factor of 'satisfaction' has to be considered, since learners have to feel that what they are learning has a value, and the efforts they are making are constructive and valuable.

Moreover, challenge, fantasy, control and curiosity should be considered in the design of a quality serious game, which are directly linked to enjoyment and entertainment (*Ibidem*). The presence of challenges includes the possibility of cooperation, or competition, whether social networks' features are taken into account in the gamification framework. Social networks are particularly suitable to rise recognition. Recognition has to be intended as the awareness of reaching a level in the game through efforts and abilities, letting this information be available to other learners-players in a way that other players can see the achievements reached by all the competitors. In this way, a player can be recognized by his role, his position in a leader board, for example (Pinelle & Gutwin, 2008).

Another key element of a GBLE is its capacity to introduce and sustain social dynamics, such as competition as well as collaboration. Such social dynamics help learners draw back; this is particularly true if the competition can be held inside of a community of friends, colleagues, classmates, and if the game includes the possibility of a leader board to compare performances and create social status.

Then, besides a perceived ease of use, the process of identification with the game play is also relevant in the design of digital game-based solutions. Using customizable avatars, learners can express their identity trajectories during learning activities, having a personal dimension inside the virtual environment of the game (Prensky, *op. cit.*).

Games are therefore complex system with many variables. Multiple ele-

ments are required, to make a game a meaningful learning experience. The interplay of the elements makes the difference for the most successful games. Game elements often contain advantages over traditional presented learning content, working individually and collectively to create the game playing experience. Learning professionals use many of these elements already and can mix them to create powerful learning outcomes.

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.

Indeed, although serious games about nutrition are yet reported in the market place, less research has been done to attempt to integrate both healthy eating education and serious game principles (Baranowski *et al.*, 2008; Lee *et al.*, 2010). Especially, the review of literature revealed that the linkage between the use of serious game and players' health-related behavior change was relevant (Baranowski *et al.*, *op. cit.*; Boulos, 2012; Maillot *et al.*, 2012; Owens *et al.*, 2011); nevertheless, little has been said about the qualities of the serious games as systems able to influence the attitudes and the health-related behavior change. Accordingly, this is the main point of our empirical research.

3 Case study

3.1 Cibopolis as a prototype of digital game-based learning environment

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[1]), 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' was 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.

[1] www.helplarge.com

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 evaluates the learners' posts in the virtual forums thus authorizing their online publication.

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

The five areas and related dynamics are:

1. House. This is the place in which learners may create their personal and humanized avatar and play the mini-game '5 daily meals' cups'. Moreover, the house introduces learners in the space of social networking, too.
2. Market. This is the environment that supports the game logic of '5 daily meals' cups'. Learners may buy the proper foods for composing their daily Mediterranean meals.
3. Municibio. This is the place in which learners may choose the missions about nutrition, participate to the social networking activities in the blog and forum spaces. Moreover, every learner may view the top of the player ranking.
4. Gym. It is the area in which 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.

3.2 Method – The aim: learner perception of the digital serious game Cibopolis

Consistent with the general objective of the present study, which 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' attitudes and 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. Figure 1 gives a preview of the hypotheses described below.

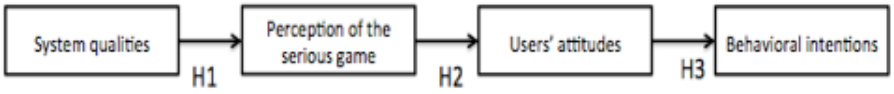

Fig. 1 - Hypotheses scheme.

Specifically, we first hypothesized that the qualities of the system Cibopolis, as the multimedia and structural adequacy, the clarity of objectives, would have positive effects on the perception of the serious game. Second, we hypothesized the learners' perception of the serious game Cibopolis significantly influenced their attitudes, which in turn affected their behavioral intentions.

3.3 Participants, measures and procedure

The participants in the present study were people (N=65), who ranged in age from 14-32 years old. First, they were involved in a training session about the use of the serious game Cibopolis. Every training session lasted about two hours; it was organized in order to involve learners in exploring every areas and dynamics of Cibopolis. A total of three training section was delivered: a session was organized in the office of the University of Bari; the others was organized in two different secondary schools placed in Bari.

After using Cibopolis, learners filled in a questionnaire, composed of the System Usability Scale (SUS) and a scale ad hoc built to test our main hypotheses regarding the effects of the system Cibopolis on the learner attitudes and behaviors, as well. Thus, the learner perception of the digital serious game Cibopolis was measured in two steps.

The System Usability Scale (SUS)

The System Usability Scale (SUS – Brooke, 1996) provides a quick and reliable tool for measuring the usability, which can be best summed up as being a general quality of the appropriateness to a purpose of any particular artifact.

Within Brooke (*Ibidem*), the usability of any tool or system has to be viewed in terms of the context in which it is used, and its appropriateness to that context.

With particular reference to information systems, this view of usability is reflected in the current draft international standard ISO 9241-11 and in the European Community ESPRIT project entitled Measuring Usability of Systems in Context (MUSiC) (Bevan *et al.*, 1991).

In general, it is not possible to specify the usability of a system without first defining who are the intended users of the system, the tasks those users will perform with it, and the characteristics of the physical, organizational and social environment in which it will be used.

SUS is a 10-item questionnaire; responses were obtained on a five-point Likert-type scale from ‘strongly disagree’ to ‘strongly agree’. The SUS items are the following:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were strongly integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very

quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn many things before I could get going with this system.

Respondents should be asked to record their immediate response to each item, rather than thinking about items for a long time. All items should be checked. If a respondent feels that they cannot respond to a particular item, they should mark the center point of the scale.

To calculate the SUS score, first we have to sum the score contributions from each item. Each item's score contribution will range from 0 to 4. For items 1, 3, 5, 7 and 9 the score contribution is the scale position minus 1.

For items 2, 4, 6, 8 and 10, the contribution is 5 minus the scale position. Then we have to multiply the sum of the scores by 2.5 to obtain the overall value of SU. SUS scores have a range of 0 to 100. Based on research, a SUS score above a 68 would be considered above average and anything below 68 is below average.

The scale was originally assumed to be one-dimensional, but a recent work (Lewis & Sauro, 2009) revealed that the SUS actually has two factors, learnability, composed by 2 items (4 and 10), and usability, composed by the remaining 8 items. Although the SUS is popular and deeply tested, many companies prefers to develop their own standard for usability measurement, and sometimes their own definition of usable product (Kankaanranta & Neittaanmäki, 2009).

The SUS is the de facto recommended measurement method for simple linear games, where the player is attempting to achieve a single goal at a time/level through a relatively standard method of completing the level or winning the game.

The effects of the system Cibopolis on the learner attitudes and behaviors: the items ad hoc built

To test our main hypotheses, items on the effect of the system on the learner attitudes and behaviors was ad hoc formulated. Specifically, the construct definition of System quality was built based on the system usability conceptions (Lewis & Sauro, *op. cit.*).

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 im-

provements, engagements, achieved goals).

Table 1 reported the constructs and the related items.

Since the size of the respondents' sample was small for a proper analysis, we carried on an exploratory factor analysis loading the single constructs, measuring independence considering groups of constructs two by two.

Despite this, we tempted to study our model in terms of exploratory structural equations. We tested the path model, which evaluates our hypotheses (see Figure 1) on the causal relationships among these evaluation constructs.

3.4 Results

Consistent with the SUS analysis and following the instruction to compute the SUS score, Cibopolis obtained a score of 75.22 over 100, and therefore it can be considered 7 points over the usability average, set to be 68.

This is an important result obtained by the game. Item number one in the SUS I think that I would like to use this system frequently was the one to receive the lowest score (1.9 on a Likert's scale from 0 to 4, where 0 was considered strongly disagree and 4 strongly agree). Only 4% of respondents would like to use the serious game frequently, the 58% would use it rarely, the 12% would never use it again, while the remaining respondents hardly never.

To test our main hypotheses, we proceed with the analyses on the questionnaire ad hoc built. First internal reliability of the constructs (i.e., ease of use, multimedia and structural adequacy, and so on) was calculated. Internal reliability indices of the sub-scales is shown in Table 1.

Table 1
CONSTRUCTS DEFINITION-TEST RESULTS OF INTERNAL RELIABILITY

Constructs, factors and items	Cronbach's Alpha	Item-correlation
System qualities		
Ease of use	0.755	
The game could be simplified		0.604
The game needed to be improved		0.452
I needed of technical support to use the game		0.673
I quickly familiarized with the game		0.526
The game was difficult		0.460
Multimedia adequacy	0.778	
The graphic of the game was appropriate		0.756
The sound effects of the game were appropriate		0.506
The game was very interactive		0.611
Structural adequacy	0.454	

Constructs, factors and items	Cronbach's Alpha	Item-correlation
The different functions of the game were 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		0.701
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 game involved me in playing continuously		0.300
Behavior in the game	0.532	
I would play frequently		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 could 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 for reaching the game's goals		0.638
In Cibopolis, missions were a good way to communicate to my friends what I was doing in my daily life		0.600
Users' attitudes and behaviors		
Users' attitudes	0.839	
The game increased my awareness on nutrition		0.745
The game increased my notions on nutrition		0.801
I will check in a better way the composition of my meals		0.572

Figure 2 shows the results of the path analysis, useful to examine the significance of the paths associated with these variables. The Goodness of Fit (GFI) and Comparative fit indexes (CFI) were calculated. The GFI was significant. Instead, Comparative fit indexes were slightly under the significant threshold of 0.9. This could be caused by the size of the sample, and did not necessarily mean that our hypotheses should be rejected. We should better refer to an under identified model, since model parameters cannot be estimated appropriately due to the lack of information available on which to base the parameter estimates (Babyak & Green, 2010).

Figure 2 shows the results of our analysis: a dashed arrow represented moderately significant influences (β >.30); a continuous line arrow represented strongly significant influences (i.e., β <.30).

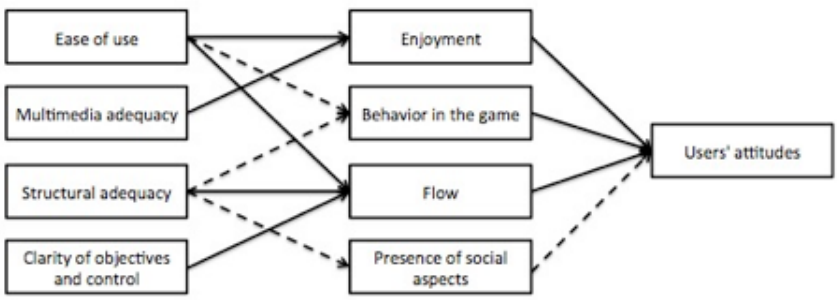

Fig. 2 - Model paths.

We first examined the path relationships between constructs included in System qualities and the ones in Perception of the serious game. It showed that enjoyment was statistically significantly influenced by ease of use ($\beta = 0.52$, $p < 0.001$), and multimedia adequacy ($\beta = 0.31$, $p < 0.01$). Flow was significantly influenced by Cibopolis ease of use ($\beta = 0.41$, $p < 0.001$), structural adequacy ($\beta = 0.27$, $p < 0.01$), and clarity of objectives and control ($\beta = 0.36$, $p < 0.01$). Behavior in the game was moderately related to ease of use of Cibopolis ($\beta = 0.11$, $p < 0.01$), and by structural adequacy ($\beta = 0.14$, $p < 0.01$). Presence of social aspects was also moderately related to structural adequacy ($\beta = 0.12$, $p < 0.01$). As for the relationship between Perception of the serious game and Users' attitudes, we found that enjoyment showed significant influence on users' attitudes ($\beta = 0.21$, $p < 0.01$), which were also influenced by behavior in the game ($\beta = 0.23$, $p < 0.01$), and flow ($\beta = 0.21$, $p < 0.01$), while moderately influenced by presence of social aspects ($\beta = 0.11$, $p < 0.01$).

Small values for β are because respondents did not have the opportunity to test the game properly (i.e., they could not appreciate the presence of social aspects in just a two hours game session). Therefore, the need of a better analysis with a test phase spanned through a larger time span period.

Conclusion

Within a framework that draws on socio-constructivist learning approach, this paper focused on the social, constructivist and informal learning processes as relevant levers able to support the design and development of a digital serious game.

After focusing on the theoretical relationship between socio-constructivist learning and game-based learning environments design and development, this paper described Cibopolis as a digital serious game case study, able to grasp different learning processes, involving users as players in collaborative participation and knowledge building on nutrition and healthy lifestyle. Especially, we aimed at presenting a new evaluation model to an explorative assessment of the user experience in a serious game Cibopolis. An evaluation model can help to conceive and improve the product, suggesting corrective actions related to the impact that the game was intended to have.

Thus, we analyzed the digital serious games Cibopolis, which was designed to engage learners in a meaningful learning process about nutrition and healthy lifestyle. We first tested the game using the System Usability Scale obtaining a score of seven points over the average usability threshold; then, we used a three-construct questionnaire, ad hoc built, to focus on how the system qualities affects the users' perception of the serious game, their attitudes and healthy behaviors.

Our analysis showed that there was a significant relationship between the serious game Cibopolis and the learner attitudes and behaviors of nutrition and healthy lifestyle. Briefly, the findings of the present study allowed us at pointing out that the socio-constructivist learning framework has to be considered for designing effectiveness digital serious game and supporting meaningful learning processes, to sustain clearly goal-oriented activities, to enhance social networking, and to foster the acquisition of cognitive skills (problem solving, communication, and so on) and metacognition, as well.

We emphasize 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 sustain 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. According to Pannese and Carlesi (2007), game-based learning solutions seem to raise effectiveness in training and learning, for closing the gap between gaming and learning.

We acknowledge that further analysis is needed to have a better model-fit increasing the size of the considered sample. 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.

REFERENCES

Babyak M. A. & Green S. B. (2010), *Confirmatory factor analysis: an introduction for psychosomatic medicine researchers*, Psychosomatic Medicine, 72 (6), 587-597.

Baranowski, T., Buday, R., Thompson, D. I., Baranowski, J. (2008), *Playing for real: Video games and stories for health-related behaviour change*, American Journal of Preventive Medicine, 34 (1), 74-82.

Boulos, M. (2012), *Xbox 360 Kinect Exergames for Health*, Game for Health Journal, 1 (5), 326-330.

Brooke J. (1996), *SUS: A quick and dirty usability scale*, in: Jordan P., Thomas B., Weerdmeester B. A., McClelland I. L (eds)., Usability evaluation in industry. 189-194, London, Taylor & Francis Ltd.

Cole M. (1996), *Cultural psychology. A once and future discipline*, Cambridge, Harvard University Press.

Hetzner S. & Pannese L. (2009), *E-VITA, simulazioni di vita in ambito intergenerazionale*, Journal of e-Learning and Knowledge Society, 5 (2), 75-82.

Kankaanranta M. & Neittaanmäki P., eds (2009), *Design and use of serious games*, Berlin, Springer Science & Business Media.

Kapp K. M. (2012), *The gamification of learning and instruction*, San Francisco, Pfeiffer.

Keller J. M. (1987), *Development and use of the arcs model of instructional design*, Journal of instructional development, 10 (3), 2-10.

Koschmann T., ed (1996), *CSCL, theory and practice of an emerging paradigm*, Mahwah, Lawrence Erbaum Associates.

Jonassen D. H. & Rohrer-Murphy L. (1999), *Activity Theory as a Framework for Designing Constructivist Learning Environments*, ETR&D, 47 (1), 61-79.

Lave J. & Wenger, E. (1991), *Situated learning: legitimate peripheral participation*, New York, Cambridge University Press.

Lee, W., Chae, Y. M., Kim, S., Ho, S. H. & Choi, I. (2010), *Evaluation of a mobile phone-based diet game for weight control*, Journal of Telemedicine and Telecare, 16 (5), 270-275

Lewis J. R. & Sauro, J. (2009), *The factor structure of the system usability scale*, Human Centered Design, 5619, 94-103.

Ligorio M. B. (2010), *Dialogical Relationship between Identity and Learning*, Culture & Psychology, 16 (1), 93-107.

Maillot, P., Perrot, A. & Hartley, A. (2012), *Effects of interactive physical-activity video-game training on physical and cognitive function in older adults*, Psychology and Aging, 27 (3), 589-600.

McDaniel R., Fiore S. M. & Nicholson, D. (2010), *Serious storytelling: Narrative considerations for serious games researchers and developers*, in: Bowers J. C., Bowers C. (eds), Serious game design and development: Technologies for training and learning. 13-30, Hershey, IGI Global.

Matusov E. (2001), *Intersubjectivity of a way of informing teaching design for a community of learners class*, Teaching and Teachers Education, 17, 383-402.

Nardi B. A. (1996), *Activity theory and human computer interaction*, in: Nardi B. A. (ed), Context and Consciousness: Activity Theory and Human-Computer Interaction. 1-8, Cambridge, The MIT Press.

Norradin E. M. & Kian, N. T. (2015), *Three learning potentials in digital games: perception of Malaysian university teachers*, Journal of e-Learning and Knowledge Society, 11 (2), 143-160.

Owens, S. G., Garner, J. C., loftin, J. M., van Blerk, N. & Ermin, K. (2011), *Changes in Physical Activity and Fitness after 3 months of Home Wii Fit use*, Journal of Strength & Conditioning Research, 25 (11), 3191-3197.

Paavola S. & Hakkarainen, K. (2005), *The Knowledge Creation Metaphor. An Emergent Epistemological Approach to Learning*, Science & Education, 14, 535-557.

Pannese L. & Carlesi, M. (2007), *Game and learning come together to maximize effectiveness: The challenge of bridging the gap*, British Journal of Educational Technology, 38 (3), 438-454.

Pinelle D. & Gutwin, C. (2008), *Evaluating teamwork support in tabletop groupware applications using collaboration usability analysis*, Personal and Ubiquitous Computing, 12 (3), 237-254.

Poels K., de Kort, Y. & Ijsselsteijn, W. (2007), *It is always a lot of fun! Exploring dimensions of digital game experience using focus group methodology*, in: Kapralos B., Katchabaw M. (eds), Futureplay 2007. 83-89, New York, ACM.

Prensky M. (2000), *Digital game-based learning*. New York: McGraw-Hill.

Quisumbing L. (2005), *Education for the world of work and citizenship: towards sustainable future societies*, Prospects: Quarterly Review of Comparative Education, 35 (3), 289-301.

Scardamalia M. & Bereiter C. (2005), *Does education for the knowledge age need a new science?*, European Journal of School Psychology, 3 (1), 265-284.

Suchman L. (1987), *Plans and situated action*, Cambridge, Cambridge University Press.

Thomas D. & Brown J. S. (2007), *The play of imagination: Extending the literary mind*, Game & Culture, 2 (2), 149-172.

Vermunt J. D. & Verloop, N. (1999), *Congruence and friction between learning and teaching*, Learning and Instruction, 9, 257-280.

Vygotsky L. S. (1978), *Mind in Society*, Cambridge, Harvard University Press.

Wenger E. (1998), *Communities of practice. Learning meaning and identity*, Cambridge, Cambridge University Press.