Metadata of the chapter that will be visualized in SpringerLink

Book Title	Recent Advances in Information Systems and Technologies	
Series Title		
Chapter Title	Urban Gamification in Architecture Education	
Copyright Year	2017	
Copyright HolderName	Springer International Publishing AG	
Corresponding Author	Family Name	**Fonseca**
	Particle	
	Given Name	**David**
	Prefix	
	Suffix	
	Division	GRETEL – Grup de Recerca En Technology Enhanced Learning
	Organization	La Salle – Ramon Llull University
	Address	C/Sant Joan de La Salle 42, 08022, Barcelona, Spain
	Email	fonsi@salle.url.edu
Author	Family Name	**Villagrasa**
	Particle	
	Given Name	**Sergi**
	Prefix	
	Suffix	
	Division	GRETEL – Grup de Recerca En Technology Enhanced Learning
	Organization	La Salle – Ramon Llull University
	Address	C/Sant Joan de La Salle 42, 08022, Barcelona, Spain
	Email	sergiv@salle.url.edu
Author	Family Name	**Navarro**
	Particle	
	Given Name	**Isidro**
	Prefix	
	Suffix	
	Division	GRETEL – Grup de Recerca En Technology Enhanced Learning
	Organization	La Salle – Ramon Llull University
	Address	C/Sant Joan de La Salle 42, 08022, Barcelona, Spain
	Email	inavarro@salle.url.edu
Author	Family Name	**Redondo**
	Particle	
	Given Name	**Ernest**
	Prefix	
	Suffix	
	Division	AR&M, Barcelona School of Architecture, BarcelonaTech
	Organization	Catalonia Polithecnic University
	Address	Av/Diagonal 649, 08028, Barcelona, Spain

	Email	ernesto.redondo@upc.edu
Author	Family Name	**Valls**
	Particle	
	Given Name	**Francesc**
	Prefix	
	Suffix	
	Division	AR&M, Barcelona School of Architecture, BarcelonaTech
	Organization	Catalonia Polithecnic University
	Address	Av/Diagonal 649, 08028, Barcelona, Spain
	Email	francesc.valls@upc.edu
Author	Family Name	**Sánchez**
	Particle	
	Given Name	**Albert**
	Prefix	
	Suffix	
	Division	EGA-II, Barcelona School of Building Construction, EPSEB
	Organization	Catalonia Polithecnic University
	Address	Av/Dr. Marañon, 44-50, 08028, Barcelona, Spain
	Email	albert.sanchez.riera@upc.edu

Abstract	This paper describes early stages of an educational project focused on using gamification in architecture education. The state of the art of gamification technologies applied to education, architecture and urban design, is introduced, as well as main objectives of the project. It is based on the use of virtual reality systems on urban spaces to asses motivational, social, and spatial competences in an educational context. Finally, assessment methodology and previous design concepts are discussed.

Keywords (separated by '-')	Gamification - Education - Architecture - Multimedia - Visual representation - Urban space

Urban Gamification in Architecture Education

David Fonseca[1(✉)], Sergi Villagrasa[1], Isidro Navarro[1], Ernest Redondo[2], Francesc Valls[2], and Albert Sánchez[3]

[1] GRETEL – Grup de Recerca En Technology Enhanced Learning, La Salle – Ramon Llull University, C/Sant Joan de La Salle 42, 08022 Barcelona, Spain
{fonsi,sergiv,inavarro}@salle.url.edu

[2] AR&M, Barcelona School of Architecture, BarcelonaTech, Catalonia Polithecnic University, Av/Diagonal 649, 08028 Barcelona, Spain
{ernesto.redondo,francesc.valls}@upc.edu

[3] EGA-II, Barcelona School of Building Construction, EPSEB, Catalonia Polithecnic University, Av/Dr. Marañon, 44-50, 08028 Barcelona, Spain
albert.sanchez.riera@upc.edu

Abstract. This paper describes early stages of an educational project focused on using gamification in architecture education. The state of the art of gamification technologies applied to education, architecture and urban design, is introduced, as well as main objectives of the project. It is based on the use of virtual reality systems on urban spaces to asses motivational, social, and spatial competences in an educational context. Finally, assessment methodology and previous design concepts are discussed.

Keywords: Gamification · Education · Architecture · Multimedia · Visual representation · Urban space

AQ1

1 Introduction

Videogames are increasingly part of our life; while in the past playing videogames was considered an activity restricted to the young male demographic segment, the average age of a "gamer" is currently 35 years old and the gender distribution is remarkably balanced [1]. Moreover, the use of mobile devices for leisure activities have widened the game-playing population spectrum while introducing new genres labeled as "social gaming" and "casual gaming" [2]. Videogames have also been used in sports training, where a virtual partner increases the motivation of the subject while doing exercise in a virtual environment [3], and is beginning to find its place in the educational programs of Universities [4]. At the same time, the way games themselves are played is also evolving; the rise of livestreaming is influencing how games are designed and played [5], and game-playing is becoming a spectator sport.

The project presented in this article involves computing science, architectural and multimedia engineers' education, and public urban policy for future cities [6, 7]. One of the innovative aspects of this project is to incorporate gaming strategies in an urban collaborative environment to enhance an initial design proposal. This approach aims to incorporate actively architecture students (as urban designers), multimedia engineering

Á. Rocha et al. (eds.), *Recent Advances in Information Systems and Technologies*,
Advances in Intelligent Systems and Computing 571, DOI 10.1007/978-3-319-56541-5_34

and informatics students (as multi-platform programmers), and final users. Citizens will play with virtual models and they will generate points of view that were not considered in the original proposal. This could be useful for project improvement since informal and casual perception would be incorporated to the project design. This fact would feed back into student's education, primarily oriented towards formal content so far.

2 Literature Review

2.1 Gamification in Education

Games are created by designers/teams of developers, and consumed by players [8]. They are purchased, used and eventually cast away like most other consumable goods [9]. The difference between games and other entertainment products (such as books, music, movies and plays) is that their consumption is relatively unpredictable. The string of events that occur during gameplay and the outcome of those events are unknown at the time the product is finished [10]. We can formalize the consumption of games by breaking them into distinct components [11, 12], i.e., Rules => System => Fun, and establishing their design counterparts: Mechanics describes the components of the game, at the level of data representation and algorithms; Dynamics refers to the run-time behavior of the mechanics acting on player inputs and outputs; and Aesthetics pertains to the desirable emotional responses of game interaction evoked in the player.

The gamification in classes helps improve the connection between the material and the student. It offers the opportunity to reflect on a topic in depth and allows positive changes in behavior [13]. In this approach, learning through gamming is achieved by aligning the game mechanics with Bloom's taxonomy of learning [14], allowing learning to be classified into three domains [15]:

- Cognitive, which is taught in traditional education and implies understanding and synthesis of knowledge.
- Affective (involving emotions), which reflects the attitude toward a situation.
- Psychomotor (the physical), which is activated by requiring a union of mental and physical activity.

To encourage the use of games in learning beyond simulations and puzzles, it is essential to develop a better understanding of the tasks, activities, skills and operations that different game types can offer and examine how these might correspond to the desired learning outcomes [16].

Previous studies in learning gamification were assessed in terms of increased motivation and engagement in the learning tasks, as well as enjoyment derived from partaking in them [17]. However, these studies revealed some negative outcomes that need to be addressed, such as the effects of increased competition, task evaluation difficulties, and design features [18]. Product designers are leveraging this alignment in business contexts to "make the consumers come in, bring friends and keep coming back". The reward is often not directly related to the goal achieved, but rather serves as a notification to the player and others that a level of competence has been achieved.

Progress tracking is often enabled and guided by reward systems. Similarly, progress towards an overall objective is mapped out by a sequence of intermediate goals.

2.2 3D Architecture/Urban Models Visualization

Historically, in civil and building engineering education, visualization and understanding of 3D space was typically accomplished via the classical view (physical models and drawings), in front of 3D models and using virtual specifications. This approach is changing due to a generational change and the continuous improvement and development of technology. The new systems based on VR/AR (Virtual and Augmented Reality), Geo-Referencing, and learning gamification, will gradually reduce the control imposed on the designed tasks and scheduled presentations.

Due to the potential of virtual systems, we can strengthen the spatial skills and abilities of students while also using the essential interactive and collaborative features of these processes. Students can work with peers and teachers and participate in multitasking/multi-user collaborative and instant tracking [19]. The simplicity of completing the most basic models with the creation of new objects, light treatment, materials, textures, and shadows allows a dynamic workflow that is much faster to complete than physical scale models [20].

Additionally, the versatility of virtual worlds and their use in social networking allows for creation and collaboration with heterogeneous groups from all over the world, who can collaborate synchronously in different virtual spaces. Virtual worlds provide a combination of simulation tools, a sense of immersion and opportunities for communication and collaboration that have great potential for their application in education [21, 22]. However, as criticized in [23], many of the existing educative experiences in virtual worlds only replicate traditional approaches, such as recreating the classrooms.

Focused in the urban data, [24] proposed a generic model to support a new way of visiting a city. In this approach, instead of understanding the city as a place for tourism, the students perceive it as a place for learning in which all necessary educational resources are available. The model has been conceived as a way to encourage learners to create their own educational tours, in which Learning Points Of Interest are set up to be discovered using two models—formal (conducted by a teacher) and informal outdoor mobile learning (no educator is related to the learning experience).

Merging gamification and 3D architectural models, we can find some references in the use of gamification applied to urban planning process with citizen participation:

- "Blockholm", a game based on Minecraft promoted by the Swedish Center for Architecture and Design. The objective of the game is based on designing an intelligent city of the future from the real cartography of the city where the topography, streets, lakes, rivers, etc. are included [25].
- "Play the City", of the Play the City Foundation implemented throughout the year 2012 in different cities in Holland, Belgium, Turkey and South Africa is based on a game similar to Word of Warcraft.
- "Planit", developed in 2013, is based on Internet that aspires to broaden the attractiveness of citizen participation, making of the planning one playful aspect, although

in the background in an organizer of the various mental maps of how the citizens understands the city [26].

These all cases were worked from basic zoning proposals of general uses to large-scale digital work. They all incorporate noteworthy aspects linked to informal teaching models: citizens generate series of opinions or suggestions, which help students to see different points of view; this information improves their formal knowledge, as cases were conduct outside an academic environment; They all are focused on the urban planning. In the current project proposal, it is important to work on both an architectonic project and urban design at the right scale that allows a larger level of detail and complexity.

3 The Project: EduGAME4CITY

The project will be carried out in campus. The goal of the main hypothesis is to demonstrate that virtual gaming implementation in architectural education will improve spatial perception and students design capabilities, thanks to the augmented and immersive visual technologies. As such, in the fields related to the architecture and society, the hypothesis will identify key elements to guide, help and encourage personal initiatives in both designing processes and urban transformation. On the other hand, in the field of the multimedia/IT education, students will be duly qualified to create applications/games through skill-based learning. They should not be only leisure related but also for social and educational purposes (serious games).

3.1 Main Objectives

We will focus our efforts in order to:

- Test and evaluate the education of the urban project incorporating collaborative design, immersive ICTs (goggles, mobile devices, etc.), gamification and citizen participation.
- Improve the competence of the multimedia engineering students through the design and creation of serious games adapted to other areas of knowledge such as the architecture and the town planning.
- Test and evaluate the usability and motivation by the students of the created gamification system.
- Test and evaluate the informal education of the project thanks to the simulations, tests and evaluations of the citizens.
- Study and link the technological profiles of the users of the gamification platform with the results, understanding the results as the achievement of the challenges defined in the games, the results of the work surveys and the personal interviews.
- Determine the correlation between motivation, satisfaction and use experience, and the improvement of the space.

- Increase the motivation, implication and satisfaction of the citizen in the process of taking urban decisions through the usage of ICTs, starting with the approach of various accessible technologies depending on the profiles of every user.

3.2 Assessment Methodology

Quantitative and qualitative approaches have historically been the main methods of scientific research. Currently, a hybrid approach to experimental methodology has emerged that takes a more holistic view of methodological problems: the mixed-methods research approach. This model is based on a pragmatic paradigm that contemplates the possibility of combining quantitative and qualitative methods to achieve complementary results [27]. The quantitative approach will be based on ISO 9241-11 [28], that will be used as in other previously educational cases [6, 8], which provides usability assessment guidelines of efficiency and user satisfaction. The qualitative approach will be post-visit interviews with a representative sample of the students involved in the project, who will share their experience with the appliance of this new technology into the visit. For this final stage, Bipolar Laddering Assessment (BLA) will be used, a technique previously validated in other educational experiments [20].

4 Conclusions

At the moment, the project is at an early developmental stage. On one hand, a location has been chosen in Barcelona to perform a study case (Sant Jaume square area and surroundings Fig. 1). Final gamification zones will be defined by the city hall of Barcelona. In that area, game dynamics and modelling specifications are being created as a previous test to be implemented in final locations. In this sense, Unreal was selected as the programming system, with the possibilities to add urban furniture. Users will reach points attending to criteria of design concepts, sustainability, accessibility and cost. In addition, public space definition will be settled on punctual uses performed by the citizens: gatherings, public markets, demonstrations, etc., in a way that the students can intervene in each place with proposals that are adapted depending on the situation.

Fig. 1. Pilot study zone, with basic 3D models and images.

Acknowledgments. This research was supported by the programs BIA2016-77464-C2-1-R of the National Plan for Scientific Research, Development and Technological Innovation 2013–2016, Government of Spain, titled "Gamificación para la enseñanza del diseño urbano y la integración en ella de la participación ciudadana (ArchGAME4CITY)" and BIA2016-77464-C2-2-R of the National Plan for Scientific Research, Development and Technological Innovation 2013–2016, Government of Spain, titled "Diseño Gamificado de visualización 3D con sistemas de realidad virtual para el estudio de la mejora de competencias motivacionales, sociales y espaciales del usuario (EduGAME4CITY)".

References

1. Interactive Digital Software Association: Essential facts about the computer and video game industry (2002). Accessed 16 August 2016
2. Valls, F., Redondo, E., Fonseca, D., Garcia-Almirall, P., Subirós, J.: Videogame technology in architecture education. In: Kurosu, M. (ed.) HCI 2016. LNCS, vol. 9733, pp. 436–447. Springer, Cham (2016). doi:10.1007/978-3-319-39513-5_41
3. Irwin, B.C., Scorniaenchi, J., Kerr, N.L., Eisenmann, J.C., Feltz, D.L.: Aerobic exercise is promoted when individual performance affects the group: a test of the kohler motivation gain effect. Ann. Behav. Med. **44**, 151–159 (2012)
4. Conditt, J.: "Citizen Kane" to "Call of Duty": The rise of video games in universities. http://www.engadget.com/2015/10/01/video-games-film-history-education-ashley-pinnick/
5. Orland, K.: Twitch plays everything: how livestreaming is changing game design. http://arstechnica.com/gaming/2015/10/twitch-plays-everything-how-livestreaming-is-changing-game-design/
6. Fonseca, D., Redondo, E., Valls, F., Villagrasa, S.: Technological adaptation of the student to the educational density of the course. A case study: 3D architectural visualization. Comput. Hum. Behav. (2016) AQ2
7. Redondo, E., Sánchez, A., Fonseca, D., Navarro, I.: Geo-e-learning for urban projects. New educational strategies using mobile devices. A case study of educational research. Archit. City Environ. **8**(24), 100–132 (2014)
8. Villagrasa, S., Fonseca, D., Durán, J.: Teaching case: applying gamification techniques and virtual reality for learning building engineering 3D arts. In: Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality, October 2014, pp. 171–177. ACM (2014)
9. Institute of Play (2013). http://www.instituteofplay.org/work/projects/quest-schools/quest-to-learn/
10. Manrique, V.: Epic win blog: the 35 gamification mechanics toolkit v2.0 (2013). http://www.epicwinblog.net/2013/10/the-35-gamification-mechanics-toolkit.html
11. Hunicke, R., LeBlanc, M., Zubek, R.: MDA: a formal approach to game design and game research (2004). http://www.cs.northwestern.edu/~hunicke/MDA.pdf
12. Leblank, M.: Wight kinds of fun (2001). http://8kindsoffun.com/
13. Kapp, K.M.: The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education. Wiley, USA (2012)
14. Zichermann, G., Cunningham, C.: Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps. O' Reilly Media Inc, USA (2011)
15. Bloom, B.S.: Thought processes in lectures and discussions. J. Gen. Educ. **7**(3), 160–169 (1953)

16. Cronk, M.: Using gamification to increase student engagement and participation in class discussion. In: Amiel, T., Wilson, B. (eds.) Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications, pp. 311–315 (2012)
17. Hamari, J., Koivisto, J., Sarsa, H.: Does gamification work? – a literature review of empirical studies on gamification. In: Proceedings of the 47th Hawaii International Conference on System Sciences, Hawaii, USA, 6–9 January 2014
18. Connolly, T.M., Boyle, E.A., MacArthur, E., Hainey, T., Boyle, J.M.: A systematic literature review of empirical evidence on computer games and serious games. Comput. Educ. **59**(2), 661–686 (2012)
19. Calongne, C.M.: Educational frontiers: learning in a virtual world. EDUCAUSE Rev. **43**(5), 36 (2008)
20. Redondo, E., Fonseca, D., Valls, F., Olivares, A.: Enseñanza basada en dispositivos móviles. Nuevos retos en la docencia de la representación arquitectónica. Caso de estudio: Los Tianguis de Tonalá, Jalisco, México.EGA. Revista de expresión gráfica arquitectónica **21**(27), 64–73 (2016)
21. Baker, S.C., Wentz, R.K., Woods, M.M.: Using virtual worlds in education: Second Life® as an educational tool. Teach. Psychol. **36**(1), 59–64 (2009)
22. Shen, J., Eder, L.B.: Intentions to use virtual worlds for education. J. Inf. Syst. Educ. **20**(2), 225 (2009)
23. Girvan, C., Savage, T.: Identifying an appropriate pedagogy for virtual worlds: a communal constructivism case study. Comput. Educ. **55**(1), 342–349 (2010)
24. Gordillo, A., Gallego, D., Barra, E., Quemada, J.: The city as a learning gamified platform. In: 2013 IEEE Frontiers in Education Conference, pp. 372–378. IEEE (2013)
25. Majury, K.: Imagination made red in blockholm. GeoInformatics **17**(1), 10 (2014)
26. Jain, A., Das, D., Gupta, J.K., Saxena, A.: Planit: a crowdsourcing approach for learning to plan paths from large-scale preference feedback. In: 2015 IEEE International Conference on Robotics and Automation (ICRA), pp. 877–884. IEEE (2015)
27. Fonseca, D., Redondo, E., Villagrasa, S.: Mixed-methods research: a new approach to evaluating the motivation and satisfaction of university students using advanced visual technologies. Univ. Access Inf. Soc. **14**(3), 311–332 (2015)
28. Gediga, G., Hamborg, K.C., Düntsch, I.: The IsoMetrics usability inventory: an operationalization of ISO 9241-10 supporting summative and formative evaluation of software systems. Behav. Inf. Technol. **18**(3), 151–164 (1999)

Author Query Form

Book ID :	**448413_1_En**
Chapter No.:	**34**

Springer
the language of science

Please ensure you fill out your response to the queries raised below and return this form along with your corrections

Dear Author
During the process of typesetting your chapter, the following queries have arisen. Please check your typeset proof carefully against the queries listed below and mark the necessary changes either directly on the proof/online grid or in the 'Author's response' area provided below

Query Refs.	Details Required	Author's Response
AQ1	Please confirm if the corresponding author is correctly identified. Amend if necessary.	
AQ2	Please provide volume no and page range for Ref. [6].	

MARKED PROOF

Please correct and return this set

Please use the proof correction marks shown below for all alterations and corrections. If you wish to return your proof by fax you should ensure that all amendments are written clearly in dark ink and are made well within the page margins.

Instruction to printer	*Textual mark*	*Marginal mark*
Leave unchanged	··· under matter to remain	
Insert in text the matter indicated in the margin		New matter followed by or
Delete	through single character, rule or underline or through all characters to be deleted	or
Substitute character or substitute part of one or more word(s)	through letter or through characters	new character or new characters
Change to italics	under matter to be changed	
Change to capitals	under matter to be changed	
Change to small capitals	under matter to be changed	
Change to bold type	under matter to be changed	
Change to bold italic	under matter to be changed	
Change to lower case	Encircle matter to be changed	
Change italic to upright type	(As above)	
Change bold to non-bold type	(As above)	
Insert 'superior' character	through character or where required	or under character e.g. or
Insert 'inferior' character	(As above)	over character e.g.
Insert full stop	(As above)	
Insert comma	(As above)	
Insert single quotation marks	(As above)	or and/or or
Insert double quotation marks	(As above)	or and/or or
Insert hyphen	(As above)	
Start new paragraph		
No new paragraph		
Transpose		
Close up	linking characters	
Insert or substitute space between characters or words	through character or where required	
Reduce space between characters or words	between characters or words affected	