



The Current Situation and Enlightenment of “Simulation Game” Application in Architecture and Planning Education in Europe and America

Ting Li^(✉), Ting Xue, Jiaqi Yang, Zi’ang Zhang, Quan Shi, Jiahao Wu, and Jiahao Tian

Xi’an Eurasia University, Xi’an 710000, China
liting3@eurasia.edu

Abstract. The article firstly elaborates on the current learning situation of contemporary university students and defines and classifies the concept of simulation games. Then it summarizes the development status of two types of games in university education in Europe and America, analyzes the influence and lessons of simulation games on architecture and planning education, and finally points out the practical problems and future directions that need to be solved in the process of developing gamification education in China.

Keywords: Architecture and Planning Education · Simulation Game · Gamification Education · Europe and America

1 Introduction

Contemporary college students have become impatient and tired of traditional teaching model [1]. The new generation growing up under the rapid development of the Internet, they have more complicated means to obtain information, which means traditional exam-oriented education need to be changed in line with the times, and should actively introduce Internet technology in the classroom, enhance the flexibility of classroom teaching, meet the aesthetics of contemporary young people, and arouse the interest of them.

Simulation game teaching can be strictly considered as part of experiential teaching and learning, which is characterized by vivid teaching process, high interactivity and participation of participants, and has been commonly used in western universities to improve teaching effectiveness, especially in business school education. J. Elina and A. Kirsi conducted in-depth interviews with 22 senior university faculty members with project management teaching backgrounds and found that game-based instruction was effective in generating student interest and deepening their understanding of the subject matter [1]. Y. M. Huang, L. M. Silitonga, and T. T. Wu et al. found that the combination of a management simulation game and a flipped classroom had a positive impact on

undergraduate students' awareness, engagement, and academic performance, and helped students translate theory into practice [2, 3].

Architecture and planning students' understanding of space and cities is an important skill for the future [4]. Traditional education is mostly conducted using a combination of theoretical education and practical projects, and is based on CAD, SketchUP, Rhino, and other software for building flat and three-dimensional models. With the development of online video games, architecture and planning education should timely introduce of simulation games to enhance the educational interest, especially for freshmen. In this paper, we will summarize the current situation of the application of simulation games in the field of architecture and planning education in Europe and America and make suggestions for the future development in China.

2 Hot Spot Analysis

Simulation, in its simplest definition, is just "representation of reality or some known process/phenomenon". Simulations allow "what-if" analysis on a number of different solutions, which may not be feasible in reality [5]. A simulation game (SLG) is a game, which has elements like score, performance rating, conflict, and payoff, and simulates a real world situation for decision-making or alternative evaluation.

In the field of Architecture and Planning Education, it can be simply divided into "offline role-playing" and "online immersive games" according to whether or not a computer is required. Offline games can be done through face-to-face role-playing, such as in the Environmental and Community Design course at the University of Hong Kong, where each student character is assigned a different background and position to discuss a complex issue with multiple interest groups in the form of a seminar [6]. Online games, such as "Prisme-7" at the Pompidou Center in Paris, are e-games that must be played with a computer or other electronic device, in which the space of the museum is transformed into a 3D model and 40 works of art from the museum's collection are selected to be explored [7]. After passing the game, visitors can view the artworks they have searched for during their journey. This article focuses on the current state of online immersive games in architecture and planning education, which can be discussed in two broad categories: 3D Architecture /Urban Models Visualization Game and Virtual and Augmented Reality Game.

2.1 3D Architecture/Urban Models Visualization Game

Over the past few years, several professional organizations, such as the Royal Institute of British Architects (RIBA), have commissioned extensive research to gauge the current state of undergraduate architectural education and to develop an agenda for improvement [8]. Subsequently, discussions and research on the use of scenario simulation in architectural education have followed. As of today, there are up to hundreds of various games that combine 3D models with architectural planning visualization, of which the following are the main high-profile ones:

SimCity, first released in 1989, has gathered a large number of users worldwide.



Fig. 1. Game screen of Cities: Skyline

Minecraft, released in 2009, focuses on allowing players to explore, interact and change a world dynamically generated from many 1m^3 -sized cubes, and is also used by many players to build cities.

Terraria, a high freedom sandbox game, released on May 16, 2011 on PC. Compared to Minecraft, which also has building features but tends to be more of a combat, trading mode.

Cities: Skylines, which is a complete city-building simulation game, released in 2015, in which, as the mayor of a city, players will face the challenge of balancing various necessary needs, such as education, hydroelectric power, police, firefighting, medical and many other issues, with a strong sense of realism and professionalism (Fig. 1).

The Game of Cities: Skyline has been introduced into architectural education. According to the official course information of the University of Sheffield, they have used the “Cities: Skyline” game in the course “Sustainable development: a critical investigation” [9]. The aim is to help students understand and reflect on the concepts and approaches to sustainable development. It has even been used by urban planners and universities in the United States for advisory activities and planning competitions, such as when Vanessa Haddad, Assistant Professor of Liberal Studies and Chair of Liberal Arts at the State University of New York (SUNY), used the game to teach an introductory sociology course [10]. UK scholar Steve Connelly credits Cities: Skyline with enhancing students’ understanding of subject-specific material and exercising critical thinking and reflective learning skills [11]. In 2015, Aalto University began experimenting with “Cities: Skyline” in real estate and land use planning research. Professor Pyy Hahtela of the university argued in detail the possibility of using cities: skyline in teaching, arguing that although the game has problems such as lack of land tenure, it can still be used as an educational game due to its excellent overall modelling of the city as a system [12]. Some teachers at Bauhaus University, the world’s leading art university, consider simulation games as a tool to enhance students’ motivation and believe that deep gamification of education deserves further systematic research [13] (Table 1).

Table 1. List of 3D Modeling Game Application

No.	University Name	Courses/Major	Level	Application Game
1	Sheffield University	Sustainable development: a critical investigation	Master	Cities: Skyline
2	State University of New York	introductory sociology course	Postgraduate	SimCity; Cities: Skyline
3	Aalto University	Urban Planning and Development	-	Cities: Skyline
4	Bauhaus University	Urban Water Management	Postgraduate	SimCity 4
5	Rocky Mountain College of Art and Design	moral philosophy and cites	Postgraduate	Fallout Shelter

2.2 Virtual and Augmented Reality Game

The concept of Augmented Reality (AR) and Augmented Virtuality (AV) were created in 1994 by Milgram and Kishino [14]. It is a computer simulation system that allows the creation and experience of a virtual world, which uses a computer to generate a VR/AR technology entered a period of rapid development after 2010.

In 2015 HTC took the lead in releasing the first VR device VIVE with a positive orientation to PC games, which is the pioneer and benchmark of VR devices. In May 2018, the VR audio game Beat Saber went on sale in STEAM, instantly igniting an unprecedented VR game fever. Alyx, which is the FIEST official listing of a large VR game, was released in 2020. As of now, there are still no VR construction games released, the VR application research in the field of construction is mostly for the construction of professional interactive platforms, such as architectural design platform, building construction platform, building decoration platform, etc.

In VR educationalization research, Steven K. Ayer found that the use of VR in object cognition-based learning can see significantly improved teaching effectiveness [15]; Yuxuan Zhang, Hexu Liu argued that VR/AR can be used to enhance design understanding as well as spatial perception and spatial relationships [16]; Goedert, James D. and Rokooei, Saeed developed a virtual interactive construction education platform to provide building construction safety training through the use of simulation and modelling [17]. Dorta team has been developing immersive design platforms for many years, the Hybrid Ideation Space (HIS) and lately the HYVE-3D (Hybrid Virtual Environment-3D) promote immersive ideation and synchronous collocated or remote design collaboration. The CDP (Collaborative Design Platform) offers a relevant visualization setting combining a tangible tabletop system and a SDAR application in the last version of that prototype [18]. With the development of BIM, VR has been organically integrated with BIM.

In practical university applications, Penn State University has introduced a course on “3D Modeling and Virtual Reality”, aims to use various software solutions for 3D model creation. Kalisperis et al. made an experiment at Penn State University with the aim to enrich the design process with the use of an immersive space (V-shaped screen) [19]. Students at Cornell University were able to immerse themselves in the 3D environments of a Syrian refugee camp, the Great Wall of China, and ancient Rome through a VR headset, exploring places and buildings in a way that was as close to reality as possible. 3D Modeling and Virtual Reality was established in June 1997 at University College London and Imperial College London, and by now, VR/AR technology has been applied to their design, construction, and operations processes. A VR educational simulation game: The Design Review Simulator (DRS)’s design and developing processing were firstly published by Dr. F. Castronovo, Ms. V. Shroff, Dr. S. Yilmaz from California State University [20]. The game took a lot of effort, and California State University invited the University of Reading and the University of Brescia, as well as industry professionals to form a research team, and it took years of work to make the game available, but it is still not commercialized or widely available.

Therefore, it can be found that there is still a blank in the market for commercial VR and VR educational games.

3 Characteristics and Enlightenment of Simulation Game Education

For a long time, China’s construction industry is still a rough and labor-intensive industry. As a pillar industry of the national economy, it has become urgent to expand digital technology and intelligent means to empower the transformation and upgrading of the construction industry. The innovation of construction education should take the lead and learn from overseas education experience to lead the gradual transformation of the construction industry.

3.1 Arousing the Interest in Learning

The simulation game can realize the interaction between students and the teaching content, bringing a more three-dimensional sense of interaction, and presenting the abstract course content in virtual scenarios. The scenario-based teaching can effectively relieve students’ emotions and enhance their interest in learning. The 3D simulation game can also synthesize the classroom content and simulate the problems that may arise in realistic urban planning or architectural engineering construction, consolidating students’ mastery of the classroom content and helping them understand and remember.

3.2 Promoting Practical Teaching

Architecture and planning design often does not have a fixed paradigm, and it is difficult to define the merits and demerits of a design simply by looking at it, especially for college students, who are new to professional learning and lack of basic knowledge or poor integration of basic knowledge, and need more practical projects to examine and strengthen the comprehensive application of knowledge. However, in reality, there is often a lack of real projects for students to learn, although many teachers will adopt the “real problems and fake work” model, but due to the lack of realism, students only get incomplete training.

By using simulation games, the offline training as a participant of interest will gain a stronger sense of participation and effectively expand the understanding of architects and planners on their own positioning; by using online simulation games, the application of various related knowledge can be integrated, for example, in *Cities: Skyline*, the player, as the mayor, has to consider the layout of all kinds of equipment and facilities in the city. In this way, players can examine and deepen their understanding and application of basic theories such as “public facilities service radius”, “road organization and planning” and “urban functional zoning”. The two approaches have different emphases and can be used in combination.

4 Conclusions

Simulation games can help students specializing in the field of architecture to understand the learning content in a multifaceted way, combining theory with reality, plane with three dimensions, stillness with dynamics. However, there are Four practical problems in the promotion of simulation games:

Difficulty in developing 3D visualization games, high development costs and post-update costs.

High cost of VR technology and equipment, high cost of operation and maintenance.

Lack of inter-professional talents, high cost of team building, and the need to have a highly that team proficient in the field of computer and architecture.

It is difficult to identify whether students are addicted to games rather than learning, so teachers need to design games very carefully, pay more attention to students, and grasp that the core of Gamification Education is learning rather than games, so as to avoid students' addiction to games leading to academic wastage.

In summary, although Europe and the United States have been exploring the educationalization of simulation games, on the whole, this way have not been around for long enough to be fully and thoroughly developed in instructional design, and have broad development prospects in China, as long as they can break through the limitations of high difficulty in developing games, huge development costs, expensive VR equipment and lack of talents.

Acknowledgments. This project is supported by the special project of technical services of Xi'an Eurasian University: Comprehensive Evaluation Study of Campus Environment Based on Human Comfort Theory - Taking Xi'an Eurasian University as An Example (Project Number: OYGJS-2021006).

Authors’ Contributions. Ting Li contributed to the conception of the study and performed the wrote the manuscript;

Ting Xue, Jiaqi Yang contributed significantly to information analysis and manuscript preparation;

Zi’ang Zhang, Quan Shi, Jiahao Wu, Jiahao Tian performed the data collection.

References

1. Elina, J., & Kirsi, A. (2022). Teachers’ experiences of using game-based learning methods. *Project Leadership and Society*, 3. <https://doi.org/10.1016/j.plas.2022.100041>
2. Huang, Y. M., Silitonga, L. M., & Wu, T. T. (2022). Applying a business simulation game in a flipped classroom to enhance engagement, learning achievement, and higher-order thinking skills. *Computers & Education*, 183. <https://doi.org/10.1016/j.compedu.2022.104494>
3. Abdullah, N. L., Hanafiah, M. H., & Hashim, N. A. (2013). Developing creative teaching module: Business simulation in teaching strategic management. *International Education Studies*, 6, 95–107.
4. Calvo, X., Fonseca, D., Sánchez-Sepúlveda, M., Amo, D., Llorca, J., & Redondo, E. (2018). Programming virtual interactions for gamified educational proposes of urban spaces. In P. Zaphiris & A. Ioannou (Eds.), *Learning and collaboration technologies. Learning and teaching: 5th international conference, LCT 2018, held as Part of HCI International 2018, Las Vegas, NV, USA, July 15–20, 2018, Proceedings, Part II* (pp. 128–140). Springer. https://doi.org/10.1007/978-3-319-91152-6_10
5. Deshpande, A. A., & Huang, S. H. (2011). Simulation games in engineering education: A state-of-the-art review. *Computer Applications in Engineering Education*, 19, 399–410. <https://doi.org/10.1002/cae.20323>
6. Liang, Z., Tong, Y., & Zhu, W. (2020). Performing Community Design: The Use of “Simulation Games” in Architectural and Planning Education. *New Architecture*, 5, 127–131.
7. Centre Pompidou Website. (n.d.). *Prisme 7: The first video game of the Centre Pompidou*. <https://www.centrepompidou.fr/en/offer-to-professionals/teachers/online-educational-resources/video-game-prisme-7>
8. Schön, D. A. (1985). *The design studio: An exploration of its traditions and potentials*. RIBA Publications.
9. The University of Sheffield. (2022). *Urban Design and Planning MA Postgraduate taught courses Website*. <https://www.sheffield.ac.uk/postgraduate/taught/courses/2022/urban-design-and-planning-ma>
10. Stanford University. (n.d.). *Tomorrow’s academic careers: The practice of game-based learning*. Stanford University. <https://tomprof.stanford.edu/posting/1756>
11. Barr, M. (2019). *The educator perspective*. Twitter. <https://www.matthewbarr.co.uk/tag/cities-skylines>
12. Haahtela, P., Vuorinen, T., & Kontturi, A. (2015). *Gamification of education: Cities Skylines as an educational tool for real estate and land use planning studies*. Game in Urban Planning, Aalto School of Engineering.
13. Söbke, H. (2018). A case study of deep gamification in higher engineering education. In *GALA 2018: Games and learning alliance* (pp. 375–386).
14. Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE Transactions on Information and Systems*, 12, 1321–1329.
15. Mizutani, W. K., Daros, V. K., & Kon, F. (2021). Software architecture for digital game mechanics: A systematic literature review. *Entertainment Computing*, 38, 100421. <https://doi.org/10.1016/j.entcom.2021.100421>

16. Zhang, Y., Liu, H., Kang, S.-C., & Al-Hussein, M. (2020). Virtual reality applications for the built environment: Research trends and opportunities. *Automation in Construction*, 118, 103311. <https://doi.org/10.1016/j.autcon.2020.103311>
17. Goedert, J. D., & Rokooui, S. (2016). Project-based construction education with simulations in a gaming environment. *International Journal of Construction Education and Research*, 1–16. <https://doi.org/10.1080/15578771.2015.1121936>
18. Dorta, T., Kinayoglu, G., & Hoffmann, M. (2014). Hyve-3D: A new embodied interface for immersive collaborative 3D sketching. In SIGGRAPH. ACM Press.
19. Kalisperis, L. N., Otto, G., Muramoto, K., Gundrum, J. S., Masters, R., & Orland, B. (2020). Virtual reality/space visualization in design education: The VR-desktop initiative. In 20th CAAD Conference Proceedings (pp. 64–71).
20. Castronovo, F., Nikolic, D., Ventura, S. M., Shroff, V., & Yilmaz, S. (2019). Design and development of a virtual reality educational game for architectural and construction reviews. In *Construction engineering division technical session 6 - Technology & simulation*.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

