Pattern Analysis of Virtual Landscape within Educational Games

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Abstract: Virtual landscape has a prominent role in digital games' virtual environment design. Since the attributes of the virtual landscape directly affect a game's characteristics, it is crucial to be explored as a design domain, apart from just being a tool for other domains' development. This study traces the gradual change of the virtual landscape in educational games and the chronological change of their carrying content, till now a gap in the literature. To examine the effect of the virtual landscape evolution and the invention of the virtual reality (VR) technology on the intended topic of the education transmitted by the games, we classified all Steam games with the education tag based on KIM'S (2016) methodology. To do so, we transmitted their introductory information, whether they support VR and are simulation games or not, to an Excel database. Then we sorted them from 1992 till 2020. The virtual landscape classification methodology revealed a significant relationship between the content, VR technology, and the virtual landscape transformation. The study anticipates a future revolution in the landscape architecture domain by jumping into the digital game industry to enhance the virtual landscape for the sake of itself, not other disciplines.

Keywords: Educational games, classification methodology, virtual landscape, virtual reality, Metaverse

1 Introduction

In the development of digital games as one of the biggest and fastest-growing industries in the world (HUDRASYAH et al. 2019), the virtual landscape (KIM 2019), or with its novel status, a Metaverse (DIONISIO et al. 2013), accounts for a large portion of the process and plays a prominent role. Its design is equivalent to the whole game's development in terms of required effort (CHOI 2012), and its characteristics directly modify the entire game's attributes (APPERLEY 2006). While various studies have considered the role of virtual reality in the landscape architecture or urban planning domain, all of them focus on adopting these technologies to enhance the quality of real space. However, contrary to the importance of virtual landscapes in digital games, it is challenging to find research taking virtual landscapes as a goal to be developed, not as a tool for enhancing other domains. The evolution of the virtual landscapes within digital games has been continued since their emergence. With the appearance of the first three-dimensional digital games content by the game Battlezone in the 80s (BOUVIER et al. 2008), their enhancement has continued till the present day. Since the 1930s, with the arising of the concept of virtual reality (CRUZ-NEIRA et al. 2018), human beings have started to feel immersed in artificial environments and interact with virtual objects (BOUVIER et al. 2008).

Due to the characteristics of this technology, its encounter with digital games has gone beyond entertainment. According to CRUZ-NEIRA et al. (2018), digital games expanded their capabilities towards education, paving the way for progress in various fields of study. According to ALVAREZ & DJAOUTI (2011), these contents, which are named educational games

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or edutainment, convey educational content along with entertainment. Educational games were released for the first time by the LOGO Programming game in 1967, educating how to code, and showing some mathematical concepts. Afterward, Oregon Trail, released in 1974, was the first game played in the classrooms and had the most significant impact on educational games' trend. While in that era, the educational games' audience were children, currently, it has been expanded to all ages (NEEDLEMAN 2017).

However, educational games are still underestimated and have the least number of players amongst other digital games. Players expect an educational game to be fun to play and gain popularity (ALLERS 2019). Hence, thanks to the Head-mounted Displays (HMD), while virtual reality increases the player's immersion in entertaining commercial digital games, its capability in simulating real environments creates the opportunity for riskless and low-cost learning in educational games (CRUZ-NEIRA et al. 2018). Additionally, thanks to virtual reality technology, the gaming industry developed further towards the concept of Metaverse. According to DIONISIO et al. (2013), Metaverse, which is more than a single virtual environment and is the network of integrated 3D virtual environments, provides an alternative world for human interaction with no restrictions. Gaming with its innovative nature is one of the reasons for the enhancement of Metaverse. The concept of Metaverse will carry the educational games beyond including virtual landscapes only as their environments, and education will directly occur in a Metaverse.

With our previous research experiences of text-based serious games (ESHAGHI et al. 2021, VAEZ AFSHAR et al. 2021), we understood an inadequacy on the player's interaction level with the provided educational content and a reluctance to follow the encountered texts. This lack led us to wonder about the role of virtual landscapes in educational games and their effect on the data comprehension rate. However, no study or research has been done regarding the gradual change of the virtual landscape in educational games and the content they transmit chronologically. Hence this research aims to see how virtual landscape in educational games has gradually evolved and how this change and the invention of virtual reality technology have affected the intended topic of education transmitted by digital games.

2 Virtual Landscape Classification Methodology

To figure out the changes that have occurred in the virtual landscapes of educational games, first, it is essential to have an understanding of how it is possible to classify the virtual landscape in the digital games. According to literature, in 2016, KIM proposed a classification methodology for digital games. According to APPERLEY (2006), the characteristics of each game are defined by the characteristics of its constituent virtual landscapes.

Table 1: Virtual landscape classification methodology by KIM (2016)

Principle	Variable 1	Variable 2	Variable 3	Variable 4
Story	Generating	Representing	–	–
Player Scale	Single	Group	Massive	–
Interaction level	None	Partial	All	–
Dimension	2D2D	2D3D	3D2D	3D3D
Space shape	Spot	Linear	Chain	Face

Hence, Kim's methodology, which follows the principles of landscape architecture, architecture, and urban planning to sort a game's type, classifies the virtual landscapes in that digital game based on five categories and sixteen variables, not the game itself. Table 1 presents the overall structure of the methodology with standards and variables.

According to KIM (2016), in this classification methodology, the player scale, which indicates the number of simultaneous players in the game, is divided into three variables. While in a digital game, a *single* player scale demonstrates only one player is in the virtual landscape, two or more users are concurrent game players with a *group* player scale. Finally, in a *massive* game, two or more groups play the game at the same time. In a digital game, the story can be either *generating* or *representing*. In a *representing* story, the elements in the virtual landscape have an assisting role in designing the virtual landscape. Contrarily, the game story is not designed based on the virtual landscape elements in a *generating* type. In these types, the player itself generates the game story. The dimension principle, which is composed of two digits, is representative of the axes in the virtual landscape and the axes in which the player can move. While the first digit is about the virtual landscape, the second one demonstrates the player's movement, which both can be *2D* or *3D*. The space shape with its four variables defines the player's movement pattern in the virtual landscape. The player can freely move within a specified boundary if the digital game has a *spot* space shape in its virtual landscape. In a *linear* landscape, the player has a restricted area but a fixed direction, the same as the *spot*. While the *chain* is a mixture of *spot* and *linear* shapes, the *face* is a virtual landscape that the player can freely move without boundaries. Finally, regarding the interaction level, there may be no environmental elements for the player to interact within a virtual landscape. In other types, the player may be allowed to *partially* interact with a set of elements or be able to be in touch with any of the objects existing in the virtual landscape during gameplay. Hence, to classify the virtual landscape of digital games, all these elements should come together in a six-digit code. From left to right, respectively, the initials of the variables represent the story, player scale, interaction level, dimension, and space shape.

3 Data Collection and Management

As mentioned, the study wants to examine the role of virtual landscapes in educational games. To do so, we filtered all existing digital games in Steam, one of the largest game platforms, with the tag education, and consequently, 2531 entries appeared. However, after adding the "game" tag, the number decreased to 1102. Afterward, by eliminating some irrelevant content, which was not educational when examined or didn’t have suitable content, the final number of games was reduced to 702. We transmitted their introductory information, including the content's title, release year, whether they support HMD or not, to an Excel database and sorted them chronologically. Since the oldest release year in Steam dates back to 1992, our study focuses on a time spectrum from 1992 till 2020. Additionally, whether something is a simulation game or not, which means a game that simulates real-world activities (JONES 2013), was further information added to the database (Table 2).

We classified these contents based on the virtual landscape classification methodology (KIM 2016) and coded the games based on their player scale, story, dimension, space shape, and interaction level. To classify the games and indicate the topic addressed, we observed game-playing videos in Twitch and YouTube Gaming, professional and popular community hubs for gamers, or investigated the videos and information provided by the developers in Steam. Finally, we played them if none of the sources were sufficient.

Table 2: Brief version of raw database

#	Game title	Year	HMD	Simulation	Subject	Result
1	Scrapping Simulator	2020	No	Yes	Business	GSP33C
2	Powerboat VR	2020	Yes	Yes	Boat driving	GGP33C
3	Papa's Quiz	2020	No	No	General info	RGN32L
			⋮			
702	Word Rescue	1992	No	No	Kids' learning	RSN22S

As a sample, *Discovery Tour by Assassin's Creed: Ancient Egypt* (Figure 1), released in 2018, is an educational game with a core content of history. This game, a living museum depicting ancient Egypt, conveys information about life, habits, and customs there by enabling the player to explore that world without conflict. This game is a walking simulator, a genre in which players explore environments accompanied by a set of notes (MCCREE 2020). However, it does not support an HMD. Its virtual landscape classification code is *RSP33F*, meaning it is *representing* in the story, *single* in player scale, *partially* interactive, with a *3D* environment enabling player movement in three axes. It is one of the rare games providing a *face* space shape, not restricting the player with a boundary.

Fig. 1: Discovery Tour by Assassin's Creed: Ancient Egypt (UBISOFT 2018)

After gathering the required data for all 702 educational games, we managed them to figure the intended results. Hence, we divided each year's data in a separate Excel sheet and made pie charts for each column title. We re-designed a new Excel sheet as final statistics using the generated graphs. In this table, we calculated the number and percentage of each title for all the years. Generating a heatmap in the database, we discovered the most and least numbers to transfer them into line and bar charts for better comprehension. However, we considered only the three most used ones regarding the subject and result code. The raw data of this research is available on the researcher's website at the following link: https://bit.ly/3naRf7y.

4 Results

As the result of this research, the graphs demonstrate a yearly increase in the number of educational games. From 1992 till 2013, only one to three games were released each year. While this number increased to 11 in 2013, we saw a significant shift in 2020. The total educational games reached 271 cases in 2020, meaning 188.2% more than 2019 and 2363.6% more than 2013. The HMD was added to the educational games in 2012 for the first time. In 2020, we had 49 cases using the HMD, 18.1% of all educational games. This amount is nearly equal to the total cases using HMD from 2012 till 2019. We analyzed what kind of subject has been taught within the educational games, and we found out that the topics got more complicated year by year. The educational games started in 1992 with the issue of kids' learning. During the time with the emergence of the HMD, the subjects like general science, history, and programming increased among the topics. From 2018 to 2020, the puzzle and mind games are at the first stage with 10.9%, 8.5%, and 15.1%, respectively. With the increasing use of HMD in educational games from 2012, we see a significant increase in the simulation category of educational games. In 2020 we had 88 simulation games which are 32.5% of the whole games of that year. This number is even more than the total cases from 1992 till 2019.

We spotted the virtual landscape has become more complicated to develop by the growth of more *generating* stories within the educational games. Since in a *generating* story, the player is free to interact with all the landscape elements, it is not limited to a specific and predefined idea and needs more consideration to design and develop. Although developers try to manipulate the players' behaviors and actions in the form of *generating* space, it will be much harder than just simple *representing* form. Also, most educational games are suitable for *generating* stories instead of developing them as *representing* forms (Figure 2).

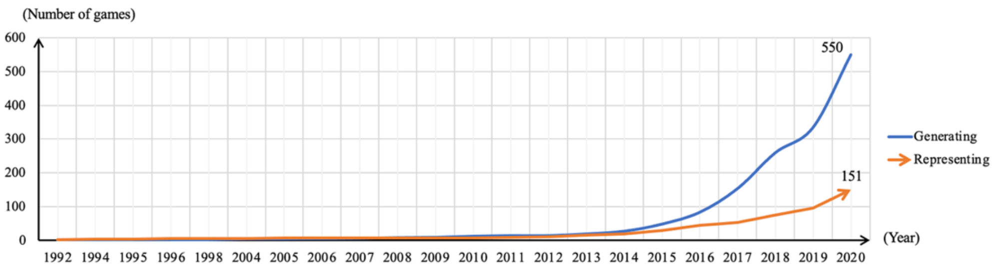

Fig. 2: The growth of the *story* principle in educational games (1992-2020)

More and more games became *group* in terms of player scale, but it is still hard to find *massive* games within the educational games (Figure 3). Additionally, still, most of the games have a *none* interaction level. However, while they became *partially* interactive more than ever, it is very hard to find any educational game with an *all* interaction level (Figure 4).

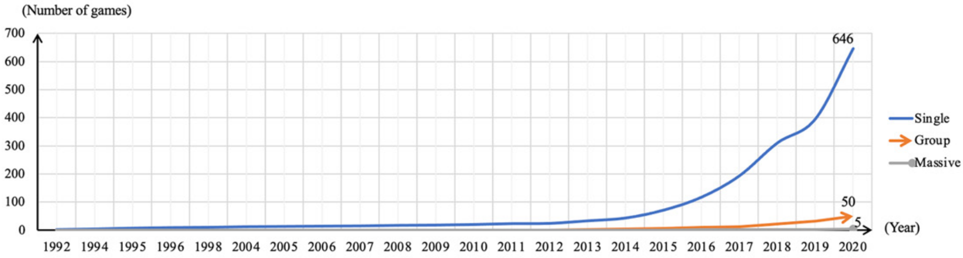

Fig. 3: The growth of the *player scale* principle in educational games (1992-2020)

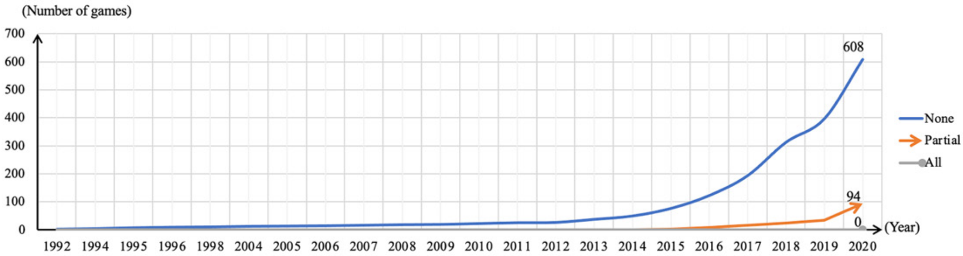

Fig. 4: The growth of the *interaction level* principle in educational games (1992-2020)

Even though the number of educational games and virtual landscape contents is increasing, the quality of the space is not very well developed yet. For instance, *non* interaction or *partially* interactive *2D2D* games, which account for the most released game types, are at the same time one of the simplest types to develop (Figure 5). Similarly, while the results show a significant rise in the number of *chain* and *spot* games, educational games with a *face* space shape are very limited in number (Figure 6).

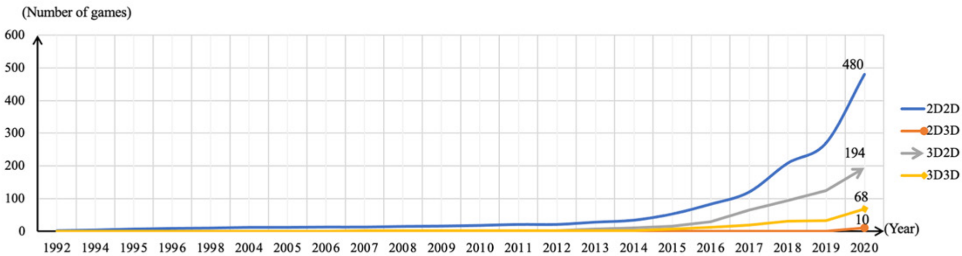

Fig. 5: The growth of the *dimension* principle in educational games (1992-2020)

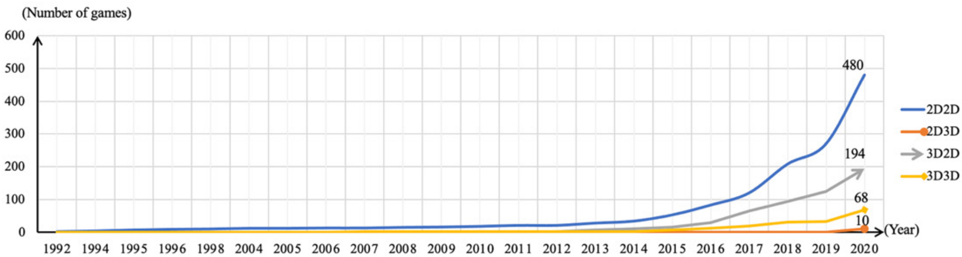

Fig. 6: The growth of the *space shape* principle in educational games (1992-2020)

5 Conclusion and Outlook

As the result of this research, we spotted a gradual change pattern in the classification code of the digital games, depicting how time and developing visualization, modeling, and virtual reality technologies changed the virtual landscapes within the educational games. The study revealed an intimate relationship between the virtual landscape revolution and the virtual reality emergence in educational games with the information they are able to convey as educational content, as more practical and less needed to be memorized. Also, the appearance of virtual reality concepts is sensible in the virtual landscape classification codes by increasing the interaction rate in educational games. It means the interaction level causes a remarkable change in the code. Additionally, as anticipated before, we spotted an increase in the three-dimensional codes in the dimension part. Generally, the virtual landscape in educational games has been more complicated to generate, interactive, and rich.

This research is limited in terms of the broadness of the dating spectrum and comprehensiveness of gaming platforms. The results would have been more precise if the examined database within the study included a variety of platforms for more old games and a broader period with newer educational games after 2020. Our future studies aim to provide a road map for educational game developers to increase the educational content retention success rate by raising the player interaction with the surrounding virtual landscape within the game. While multiple studies, such as VAEZ AFSHAR et al. (2021), focused on the data retention rate amongst the players, and some others proposed frameworks for developing quality educational games (ANNETTA 2010), no research had been done regarding its relationship with the virtual landscape in the educational games.

Finally, this result is not restricted to educational games only. It is possible to apply the final pattern to any virtual landscape to increase the interaction rate of the user with the intended environment. As KIM (2019) mentioned, landscape architecture is currently trying to merge this new virtual reality technology into its domain. However, this domain is still simply adopting virtual reality as a tool to help design activities in the real world. Soon, the virtual landscape will become an additional design domain for landscape architects. When that time comes in the near future, the result of this research will be a clue and a roadmap to generate landscapes with high interaction capability for digital games, educational games, virtual reality, or even for Metaverse. Therefore, sooner or later, landscape architects will have a great role in the virtual landscape within the digital game industry.

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