ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

VIRTUAL LANDSCAPE IN SERIOUS GAMES: A FRAMEWORK FOR ENHANCING THE PLAYER INTERACTION FOCUSING ON THE LEARNING RATE

M.Sc. THESIS

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Department of Landscape Architecture

Landscape Architecture Master Programme

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CİDDİ OYUNLARDA SANAL PEYZAJ: ÖĞRENME ORANINA ODAKLANARAK OYUNCU ETKİLEŞİMİNİ GELİŞTİRMEK İÇİN ÇERÇEVE

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To my Family,

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ABBREVIATIONS

ICT **:** Information and Communication Technologies

VR **:** Virtual Reality

HMD **:** Head-Mounted Display

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VIRTUAL LANDSCAPE IN SERIOUS GAMES: A FRAMEWORK FOR ENHANCING THE PLAYER INTERACTION FOCUSING ON THE LEARNING RATE

SUMMARY

Throughout history, education has always been essential for humanity's justice and fundamental for the creation of a free and satisfying society with the dissemination of knowledge. Hence, in addition to the life occurrences educating people, traditional higher education methods have played an important role for a long period. However, the age of technology has changed the educational system along with the people's lifestyles to meet the continuously changing conditions. During the past twenty years, the Information and Communication Technologies (ICTs) led to the emergence of e-learning non-traditional educational methods bringing about an innovative dimension of virtual learning. With its beneficial features provided by the Internet and various technologies, this method passes the control of time and location from the tutors to the students during the learning process.

Despite the entrance of online education into the students' life many years ago, the Covid-19 outbreak initiated in 2020 turned this method into the only possible way of education for almost two years. Afterward, plenty of studies investigated its effects on students' social and academic life, mostly considering its negative impacts on their mental health and motivation due to interaction issues. They also pointed out the specific problems of tactile learner students in the lack of face-to-face design courses.

As an innovative solution able to be adopted, game technologies, increasing immersion of the learner in a real-world skill, and triggering motivation are one of the best methods integrated into educational systems. Known as serious games, these games, adopted by almost any domain, convey educational content along with entertainment, increasing interaction. They train or enhance a certain skill or topic to the player by immersing them. While serious games are more expanded nowadays, they are still not being played by the mass public due to people's immersiveness expectations of a game. Hence, the Head-Mounted Displays (HMDs), with their emergence, increased the players' engagement and immersion with all types of virtual environments in digital games. This technology, however, evolved serious games area most, among others, by enabling the opportunity to provide a riskless and low-cost learning environment for real-world skills. In the process of suggesting serious games as a replacement for the traditional educational methods, the most important factor is being aware of their effectiveness for education.

Generally, digital games, one of the world's biggest and fastest-growing industries, rely heavily on the virtual landscape, a major part of its development process. Its design demands remarkable effort, and it directly affects the whole game's characteristics. Hence, serious games, as a type of digital game, carry the same attributes. With the appearance of virtual reality technology, gaming started to gain more immersiveness and engagement with artificial elements and environments. Although virtual landscapes were always being developed since the emergence of

digital games, the studies taking virtual landscapes into account are mostly using them as a tool for enhancing real spaces, not as a domain for the sake of its development. While other design domains are applying various design methodologies, it is challenging to find a standard design methodology for the design and production of virtual landscapes in the gaming industry, leading to inconsistent and low-quality results. Hence, it comes to the question of what is the virtual landscapes' role in serious games and their effect on the data comprehension rate. Since the literature lacks regarding the gradual change of the virtual landscape in serious games and the content they transmit, this thesis aims to figure out the gradual chronological evolution of the virtual landscapes in serious games. It also aims to seek how this change and the virtual reality technology invention have affected the contents transmitted by digital games and its influence on the player interaction and learning rate.

To do so, in the process of this thesis, we developed, tested, and evaluated various serious games, both text-based and with 360° photos. The steps taken revealed the reluctance of the players to follow the providing educational content and their inadequacy of interaction. Hence, the thesis seeks the reasons ending to this result and the ways of increasing this learning rate. Afterward, the thesis uses a currently available but not massively used digital game classification methodology. This methodology, which is based on the principles of architecture, landscape architecture, and urban planning, classifies the games based on their constituting virtual landscapes. Hence, the thesis considers all Steam games, one of the biggest video game digital distribution services, filtered with the 'education' tag, ending in 2531 digital games. Afterward, adding the 'game' tag the result reduced to 1102 games. Finally, with some manual filterings ignoring the irrelevant content, the final number decreased to 702. Sorting chronologically, we made an Excel database including the games' introductory information, the content they transmit, their release date, if they support HMD or not, and whether they are simulation games or not. Due to Steam's dating spectrum, our database includes games dating back from 1992 to 2020. Afterward, we classified all of these games using the virtual landscape classification methodology and generated their related codes based on their player scale, story, dimension, space shape, and interaction level. Investigating the results, they revealed some growth patterns relating to the content educated in the game, the VR technology, and the virtual landscape evolution. Adding the user reviews of Steam, we reverse engineered five of the best serious games on the database due to the digital game design methodology. This methodology divides the games' virtual environment into five layers, namely, player activity map (PAM), story layer, natural environment layer, virtual environment layer, and media layer. Reverse engineering the five best digital games ever, based on the IGN database, enabled us to compare the outcomes. Due to released data, we understand how the games' assets are distributed within the various layers of the virtual environment in the most successful games.

Finally, the thesis aims to provide a framework based on these results for developing serious games to increase player interaction and enhance the learning rate. However, these results can be expanded to any virtual landscape other than only serious games' for their interaction enhancement. Currently, the landscape architecture domain only adopts the virtual landscape area as a tool for enhancing design in the real world. However, in the near future, landscape architects will perform in the virtual landscape area as a domain to be enhanced. Hence, that day, the results of this study will play an important role and will be a roadmap for generating highly interactive virtual landscapes.

CİDDİ OYUNLARDA SANAL PEYZAJ: ÖĞRENME ORANINA ODAKLANARAK OYUNCU ETKİLEŞİMİNİ GELİŞTİRMEK İÇİN ÇERÇEVE

ÖZET

Tarih boyunca eğitim, insanlığın adaleti için her zaman gerekli ve bilginin yayılmasıyla özgür ve tatmin edici bir toplumun yaratılması için temel teşkil etmiştir. Dolayısıyla insanları eğiten yaşam olaylarının yanı sıra geleneksel yükseköğretim yöntemleri de uzun süre önemli bir rol oynamıştır. Ancak teknoloji çağı, sürekli değişen koşullara uyum sağlamak için insanların yaşam biçimleriyle birlikte eğitim sistemini de değiştirmiştir. Geçtiğimiz yirmi yıl boyunca, Bilgi ve İletişim Teknolojileri (BİT), sanal öğrenmenin yenilikçi bir boyutunu getiren geleneksel olmayan eğitim yöntemlerinin e-öğrenmesine yol açtı. İnternetin ve çeşitli teknolojilerin sağladığı faydalı özellikleri ile bu yöntem, öğrenme sürecinde zaman ve mekan kontrolünü öğretmenlerden öğrencilere devretmektedir.

Online eğitimin uzun yıllar önce öğrencilerin hayatına girmesine rağmen 2020 yılında başlayan Covid-19 salgını, yaklaşık iki yıldır bu yöntemi mümkün olan tek eğitim şekli haline getirdi. Daha sonra, öğrencilerin sosyal ve akademik yaşamları üzerindeki etkilerini araştıran çok sayıda çalışma, çoğunlukla etkileşim sorunları nedeniyle zihinsel sağlıkları ve motivasyonları üzerindeki olumsuz etkilerini göz önünde bulundurmuştur. Ayrıca, yüz yüze tasarım derslerinin eksikliğindeki dokunsal öğrenen öğrencilerin özel sorunlarına da dikkat çekilmiştir.

Kabul edilmiş yenilikçi bir çözüm olarak oyun teknolojileri, öğreneni gerçek dünya becerisine alıştırmak ve motivasyonu tetiklemek, eğitim sistemlerine entegre edilmiş en iyi yöntemlerden biridir. Hemen her alan tarafından kullanılan ciddi oyunlar olarak bilinen bu oyunlar, eğlence ile birlikte eğitici içerikleri de aktararak etkileşimi artırmaktadır. Ciddi oyunlar oyuncuyu belirli bir beceriye veya konuya daldırarak eğitir veya geliştirirler. Günümüzde ciddi oyunlar daha yaygın hale gelse de, insanların bir oyuna yönelik sürükleyici beklentileri nedeniyle hala kitleler tarafından oynanmıyorlar. Bu nedenle, Başa Monte Edilen Ekranların (HMD'lerin), ortaya çıkmasıyla birlikte, dijital oyunlarda oyuncuların her türlü sanal ortamla etkileşimini ve daldırılmasını artırdı. Ancak bu teknoloji, gerçek dünya becerileri için risksiz ve düşük maliyetli bir öğrenme ortamı sağlama fırsatı sağlayarak diğerlerinin yanı sıra en çok ciddi oyun alanını geliştirdi. Geleneksel eğitim yöntemlerinin yerine ciddi oyunların önerilmesi sürecinde en önemli unsur onların eğitim açısından etkili olduğunun farkında olmaktır. Bunun için oyuncuların öğrenme oranı araştırılması gereken oldukça önemli bir konudur.

Genel olarak, dünyanın en büyük ve en hızlı büyüyen endüstrilerinden biri olan dijital oyunlar, geliştirme sürecinin önemli bir parçası olan sanal peyzaja büyük ölçüde bağlıdır. Dijital oyunlardaki sanal peyzajların tasarımı dikkate değer bir çaba gerektirir ve tüm oyunun özelliklerini doğrudan etkiler. Dolayısıyla ciddi oyunlar, bir dijital

oyun türü olarak aynı özellikleri taşır. Sanal gerçeklik teknolojisinin ortaya çıkmasıyla birlikte oyun, sanal unsurlar ve ortamlarla daha fazla sürükleyicilik ve etkileşim kazanmaya başladı. Sanal peyzajlar, dijital oyunların ortaya çıkışından bu yana sürekli geliştiriliyor olsa da, sanal peyzajları dikkate alan çalışmalar, onları geliştirme adına bir alan olarak değil, daha çok gerçek alanları geliştirmek için bir araç olarak kullanmaktadır. Diğer tasarım alanları çeşitli tasarım metodolojileri uygularken, oyun endüstrisinde sanal peyzajların tasarımı ve üretimi için standart bir tasarım metodolojisi bulmak zordur ve bu da tutarsız ve düşük kaliteli sonuçlara yol açmaktadır. Dolayısıyla ciddi oyunlarda sanal peyzajların rolü nedir sorusu ve veri anlama oranına etkisi gündeme gelmektedir. Ciddi oyunlarda sanal peyzajın kademeli değişimi ve aktardıkları içerikle ilgili literatür eksik olduğundan, bu tez ciddi oyunlarda sanal manzaraların kademeli kronolojik evrimini çözmeyi amaçlamaktadır. Ayrıca bu değişimin ve sanal gerçeklik teknolojisi icadının dijital oyunlar tarafından iletilen içerikleri nasıl etkilediğini ve bunun oyuncu etkileşimi ve öğrenme oranı üzerindeki etkisini araştırmayı da amaçlamaktadır.

Bunu yapmak için, ilk olarak, tez sürecinde hem metin tabanlı hem de 360° fotoğraflı çeşitli ciddi oyunlar geliştirerek, test ettik ve değerlendirdik. Atılan bu adımlar, oyuncuların eğitim içeriklerini takip etme konusundaki isteksizliklerini ve etkileşimdeki yetersizliklerini ortaya çıkarmıştır. Dolayısıyla tez, bu sonuca varan sebepleri ve bu öğrenme oranını artırmanın yollarını aramaktadır. Daha sonra, şu anda mevcut olan ancak yaygın olarak kullanılmayan bir dijital oyun sınıflandırma metodolojisini kullanmaktadır. Mimarlık, peyzaj mimarlığı ve şehir planlama ilkelerine dayanan bu metodoloji, oyunları sanal peyzajları oluşturmalarına göre sınıflandırır. Bu nedenle, tez, en büyük video oyunu dijital dağıtım hizmetlerinden biri olan Steam oyunlarının, 'eğitim' etiketi ile filtrelenmiş ve 2531 dijital oyunla sonuçlanan tüm oyunlarını ele almaktadır. Daha sonra, 'oyun' etiketi eklendiğinde sonuç listesi 1102 oyuna düşürüldü. Son olarak bazı manuel filtrelemeler ile alakasız içerikler göz ardı edilerek son sayı 702'ye düştü. Kronolojik olarak sıralayarak oyunların tanıtım bilgilerini, ilettikleri içerikleri, çıkış tarihlerini, HMD'yi destekleyip desteklemediğini ve simülasyon oyunu olup olmadıklarını bir Excel veritabanı olarak oluşturduk. Steam'in tarih spektrumu nedeniyle veritabanımız 1992'den 2020'ye kadar uzanan oyunları içeriyor. Daha sonra, tüm bu oyunları sanal peyzaj sınıflandırma metodolojisini kullanarak sınıflandırdık ve oyuncu ölçeğine, hikayesine, boyutuna, uzay şekline ve etkileşim seviyesi göre ilgili kodlarını oluşturduk.

Çıkan sonuçları araştırarak, oyunda eğitilen içerik, VR teknolojisi ve sanal peyzaj evrimi ile ilgili bazı büyüme kalıplarını ortaya çıkmıştır. Steam'in kullanıcı puanını da ekleyerek, dijital oyun tasarım metodolojisine dayalı olarak en iyi beş oyunu tersine mühendislikle çevirdik. Bu metodoloji, oyunların sanal peyzajını oyuncu etkinlik haritası (PAM), hikaye katmanı, doğal ortam katmanı, yapay ortam katmanı ve medya katmanı olmak üzere beş katmana ayırır. Şimdiye kadarki en iyi 100 oyunu kapsayan IGN veritabanını temel alarak beş dijital oyunun tersine mühendisliğini yapmamız, sonuçları karşılaştırmamızı sağladı. Ortaya çıkan veriler sayesinde, kullanıcı puanlarına göre en başarılı oyunlarda oyunların varlıklarının sanal peyzajın çeşitli katmanlarına nasıl dağıldığını anlıyoruz.

Son olarak, tez, öğrenme oranının artmasıyla sonuçlanan oyuncu etkileşimini artırmak için ciddi oyunların geliştirilmesi için bu sonuçlara dayalı bir çerçeve sağlamayı amaçlamaktadır. Bununla birlikte, bu sonuçlar, etkileşim geliştirmeleri için yalnızca ciddi oyunların dışında herhangi bir sanal peyzaja genişletilebilir. Şu anda, peyzaj mimarlığı alanı, gerçek dünyada tasarımın geliştirilmesi için bir araç olarak yalnızca

sanal peyzaj alanını benimsemektedir. Ancak yakın gelecekte peyzaj mimarları sanal peyzaj alanında geliştirilecek bir alan olarak performans göstereceklerdir. Dolayısıyla o gün, bu çalışmanın sonuçları önemli bir rol oynayacak ve son derece etkileşimli sanal manzaralar oluşturmak için bir yol haritası olacaktır.

1. INTRODUCTION - LEARNING; ITS IMPORTANCE AND METHODS

Due to Bhardwaj (2016), education is a crucial human morality, necessary for society, the foundation of a satisfactory life, and a clue to freedom. It unites separate individuals and conveys knowledge of the surrounding world to people for its better modification. Although life and its occurrences educate humans, regardless of age or school, the traditional learning methods in higher education areas were the predominant types of education for long decades of history. However, with the emergence of the information age and the acceleration in people's lifestyles, the traditional educational approaches failed to meet the appeared broad curriculums (Lukman and Krajnc, 2012). Over the last two decades, with the possibilities that the technologies brought about by expanding the opportunities for interaction, communication, and collaboration, computer-based learning has become higher education's icon provision (Harasim et al., 1995; Selwyn, 2007). With the evolution of Information and Communication Technologies (ICTs), the learning process has gained the novel dimension of virtual learning (Lukman and Krajnc, 2012). This dynamic and enlightening form of learning alternates the balance of students' life, education, and career by providing spatial and temporal independence of educational factors (Paik et al., 2004), enabling the learners to individually get educated or have collaborative work (Peat, 2000).

While e-learning and online education were introduced to academia many years ago, with the recent Covid-19 outbreak emerging in 2020, this modern teaching method became a must for all students and suddenly altered the educational system. Since then, several pieces of research have been done on its impacts. Literature review findings reveal that instructors and students experience mental health problems related to e-learning, like missing face-to-face interaction and socialization with tutors and classmates (Adnan and Anwar, 2020; Aristovnik et al., 2020; Husky et al., 2020).

As a possible approach to tackle the so-called issues, specifically the interaction problem that the students encounter, game technologies are one of the most popular methods implemented in the educational systems. Digital games, which in this thesis

encompasses all the games which are playable on various gaming consoles, desktops, and PCs with various operating systems, or different mobile devices, have multiple types and genres. Generally, any digital game that any member of the general public can buy is a commercial game. Serious games, as a type of digital games, by immersing the student in a real-world task or condition and triggering the students' involvement, train the students for a specific profession (Vaganova, 2019), and include educational content along with entertainment (Alvarez and Djaouti, 2011). These games that generally get implemented in the educational system as a learning method can also, in some cases, be commercial and played by the mass public. However, finding commercially playable serious games in the market is challenging.

Considering the development process of digital games in general, to figure out the reasons for them to be well playable by public or not, the constituting virtual landscape within the game accounts for a great part of the process and is of outstanding importance (Kim, 2019). Despite the importance of virtual landscapes in digital games, within the available research, virtual landscapes are viewed more as a tool to enhance other domains than a goal to be developed. While the existing studies on the landscape architecture or urban planning fields focused on the role of virtual reality in the domain, they all adopted it for real space enhancement. However, a specific series of studies have argued that virtual environments are integral parts of design processes (Kim et al., 2018; Kim et al., 2017; Kim, 2019). Through the adoption of design methodologies from landscape architecture, architecture, and urban planning, this research series aims to enhance the efficiency and quality of virtual environments. In this research, by analyzing the differences between real and virtual spaces, the researchers noted the potential of virtual landscapes to be classified based on their attributes. Consequently, they proposed a classification methodology and, subsequently, a digital game design methodology.

This thesis seeks to investigate the gradual evolution of serious games in the educational process of various domains focusing on their constituting virtual landscapes with the aim of contributing to the development of future serious games, taking advantage of the so-called methodologies concentrating on the player interaction attribute for learning process enhancement.

1.1 Purpose of Thesis

As mentioned before, a valuable potential lies behind the issue of being able to use the virtual landscapes as a design domain for its enhancement, not as a tool for other domains' development. However, a huge gap exists regarding the role of virtual landscapes in digital games as a field for enriching the virtual landscapes. This thesis aims at serious games as a type of digital game to be investigated regarding its relation with its constituting virtual landscape. Therefore, during the steps of the thesis, firstly, we developed five serious games and evaluated the player learning rate in three of them and affecting attributes. Then, we gathered a comprehensive database of serious games, filtered, and sorted them regarding the required criteria. Afterward, we classified the games' landscapes using the virtual landscape classification methodology. After figuring out the existing growth patterns, using digital game design methodology, the thesis reverse engineered five positively reviewed serious games from the database and compared its results with the reverse engineering of the five best digital games ever. Though, the thesis ended to gathering the positively influencing features of commercial games' virtual landscape in order to be implemented in serious games for the sake of learning process enhancement. Hence, the study tries to answer the following research questions:

1. What was the relation between virtual landscapes and serious games during the time? Has the growth pattern of the existing serious games affected by the emerging technologies like HMDs, changed the contents that these games can educate?
2. Can an existing digital game design methodology be used to reverse engineer and compare the current successful serious and commercial games based on user rating to both propose a framework for future serious game developers and contribute to the methodology itself? Due to the comparison results, can focusing on the interaction aspect of these games' virtual landscape contribute to the players' learning process?

1.2 Method of Thesis

The thesis follows the below steps to achieve the intended aim, divided into four chapters. In the first chapter, the introduction, the study starts with the education topic,

investigating its importance and methods within history. After the introduction in chapter one, the investigation continues with the role of digital games in education in chapter two. In the third chapter, the thesis explores the role of virtual landscapes in digital games and other domains and treats it as a design area. In the fourth chapter, the experiment part comes, including developing serious game, evaluating their learning rate, and generating a database for proposing a framework (Figure 1.1).

The introduction includes education's importance and its traditional methods from the past. Then it describes its evolution and change to the modern methods during the time with the emergence of technology and the current Covid situation. Then, it argue about the use of serious games as a possible approach to tackle online learning's accompanied problamatic issues.

The second chapter explains the role of digital games, specifically serious games, in education during the technology era. Afterward, it investigates the existing serious games.

The third chapter considers the role of virtual landscapes in serious games. It firstly initiates by describing the current role of virtual landscapes as a design tool and its capability to be a design domain. Then, it continued with two existing methodologies regarding the virtual landscapes' classification and the digital games' design.

The last chapter is the experiment part. In this chapter, the thesis firstly, states the importance of the games' effectiveness and the players' learning rate. Followed by the serious games developed till now during the thesis steps and their learning rate evalustion. Then the thesis gathers a comprehensive database of serious games in this chapter and investigates its growth pattern. Then by reverse engineering the most preferred ones, the thesis proposes a framework for serious game developers.

It states the importance of the games' effectiveness and the players' learning rate. Followed by the serious games developed till now during the thesis steps.

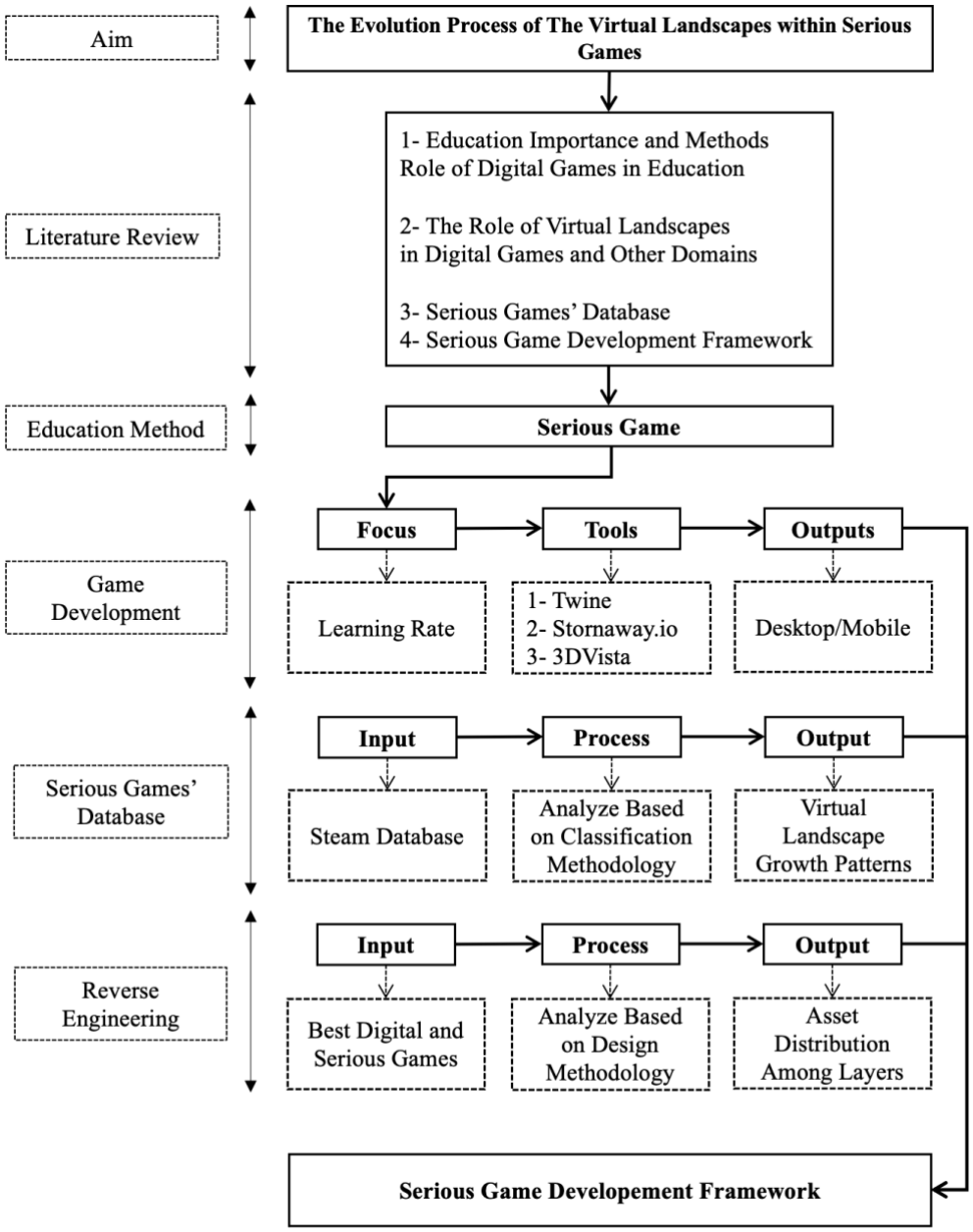

Figure 1.1 : Thesis development process.

1.3 content of Thesis

As mentioned, the scope of this thesis is serious games and their virtual landscapes. In line with the aim of the research and to find the answer to the research questions of the thesis, within the scope of the study, we used the Steam video game digital distribution service for gathering data. To include the most comprehensive data set in our pool, we filtered the existing digital games in Steam with the education tag ending in 2531 entries. Since all the available contents are not categorized as games, we added the game tag to our search criteria, and the number increased to 1102 serious games. By

eliminating the irrelevant content for ignoring non-educational games and unsuitable ones in terms of content, we reached the final number of 702 digital games. We generated an Excel sheet of the selected games, added the games' introduction information, like their release date, content, and whether they support HMDs or not, and sorted them based on their dates. The time spectrum of this database dates back to 1992, the oldest available game based on our criteria in Steam, to 2020. We also added a simulation row to the table to demonstrate whether they are simulation games or not.

This study is unique in its approach towards its aim, used methodologies, and the comprehensiveness of the gathered database. The provided framework enables the development of effective and interactive serious games with a high learning rate. Furthermore, the relied methodologies led the game developers towards a cost-efficient and consistent method, ending in high quality and balanced results. While the thesis proposes a framework for developing the virtual landscapes within serious games, the provided roadmaps could be implemented to create any virtual landscapes as a further study.

2. DIGITAL GAMES IN EDUCATION

2.1 The Evolution of Digital Games in Relation with the Virtual Landscapes

Since 1962s, when the very first computer game was released (Zackariasson and Wilson, 2010), the digital game industry, owning a huge market share, has been one of the most fast-growing global industries, with an 11% yearly average growth rate (Hudrasyah et al., 2019). Currently, it has surpassed the movie and music industries in terms of revenue (Guðjónsson, 2020) and has risen above the whole digital media market (Lange et al., 2021). More specifically, the digital game industry had a 159.3 billion USD revenue in 2020, and according to estimates, by 2023, it is expected to generate 200.8 billion USD in revenue (Newzoo, 2020). As a result of the COVID crisis, digital game sector trends in 2020 have changed significantly. Due to the desire to avoid infection, more and more people are choosing indoor activities, which has led to more active development in the games industry (Unity, 2020). Growth trends like these are unlikely to end rapidly, even after the crisis. Since the market size of digital games is getting more extensive than ever, and more people are playing games, the design process of digital games is getting more critical than ever in the current era. Additionally, people are asking for a more advanced and sophisticated level of digital games.

As one of the world's fastest-growing and biggest industries (Hudrasyah et al., 2019), digital games rely heavily on the virtual landscape (Kim, 2019) or the novel concept of Metaverse (Dionisio et al., 2013), which represents a major part of its development process. Designing it requires equal effort as developing the whole game (Choi, 2012), and its attributes directly influence the whole game's characteristics (Apperley, 2006). Virtual landscapes have been evolving within digital games since they first appeared. As three-dimensional digital games content appeared for the first time in the 1980s with the *Battlezone* game (Bouvier et al., 2008), their improvement continued from then into the present day (Figure 2.1).

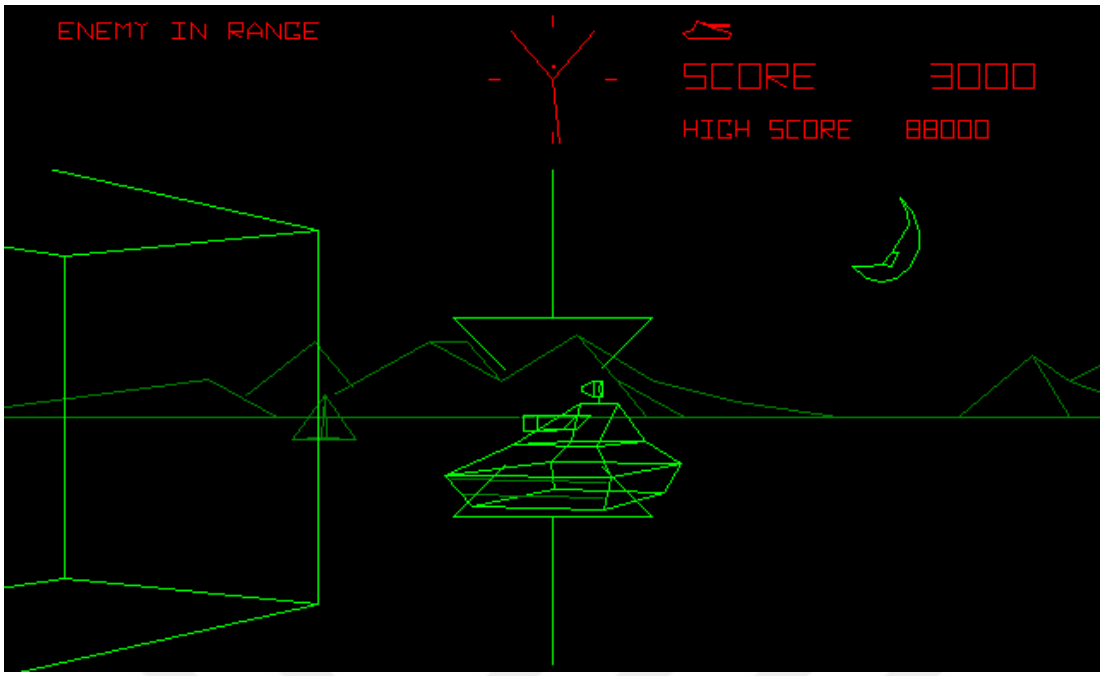

Figure 2.1 : The *Battlezone* game - 1980s (Url-1).

From the 1930s onwards, with the emergence of the virtual reality approach (Cruz-Neira et al. 2018), humanity has started experiencing the immersion feeling within artificial environments and interaction with virtual assets (Bouvier et al. 2008). This technology's characteristics made its encounter with digital games far more than just entertainment. The extension of digital games into education made it possible for progress in a variety of academic fields, according to Cruz-Neira et al. (2018). Named serious games or edutainment, according to Alvarez and Djaouti (2011), these games convey educational content in addition to entertainment.

2.2 Serious Games; The Encounter of Digital Games with the Education

As previously mentioned, game technologies are a desirable method of immersing the player in the intended topic. Gamification, which Werbach (2014) describes as " . . . the process of making activities more game-like" (p. 266), is essentially meant to motivate users to perform a particular behavior. Therefore, it supports novel behavior inductions and existing ones' reshaping (Blohm and Leimeister, 2013; Werbach, 2014). Consequently, gamification includes motivation, cognitive outcomes, and eventual behavioral changes (Hamari et al., 2014). Currently, plenty of domains take the advantage of gamification which are investigated in academia. For instance, business and marketing (Kumar, 2013), electronic market and commerce (Hamari, 2013), logistics (Hense et al., 2013), education (Li et al., 2012), healthcare (Hamari

and Koivisto, 2013), and urban planning (Setton and Eizenberg, 2020) are amongst the fields using gamification.

Regarding its use in the education domain, the content doesn't need to be serious (Seaborn and Fels, 2015), however, if the audience learns a serious subject matter during a gamification process, including educational content, it is called a serious game. Also mentioned as educational or edutainment games, serious games teach a real-world activity to the player who does not necessarily contain leisure, however, it occurs besides entertainment (Alvarez and Djaouti, 2011; Anderson et al., 2009; Becker, 2007; De Freitas and Liarokapis, 2011; Mouaheb et al., 2012). These games, which have been trendy since 2002, immerse the player in the training or enhancement of a certain topic or skill related to various professions like architecture and landscape architecture (Örnek and Seçkin, 2016). As De Freitas and Liarokapi (2011) state, serious games owe their capability of data absorption to their audiovisual nature, which eases the brain's memorizing process.

Serious games emerged with the *LOGO Programming* game for the first time in 1967, aiming to educate the students with some basic coding skills and mathematical theories (Figure 2.2).

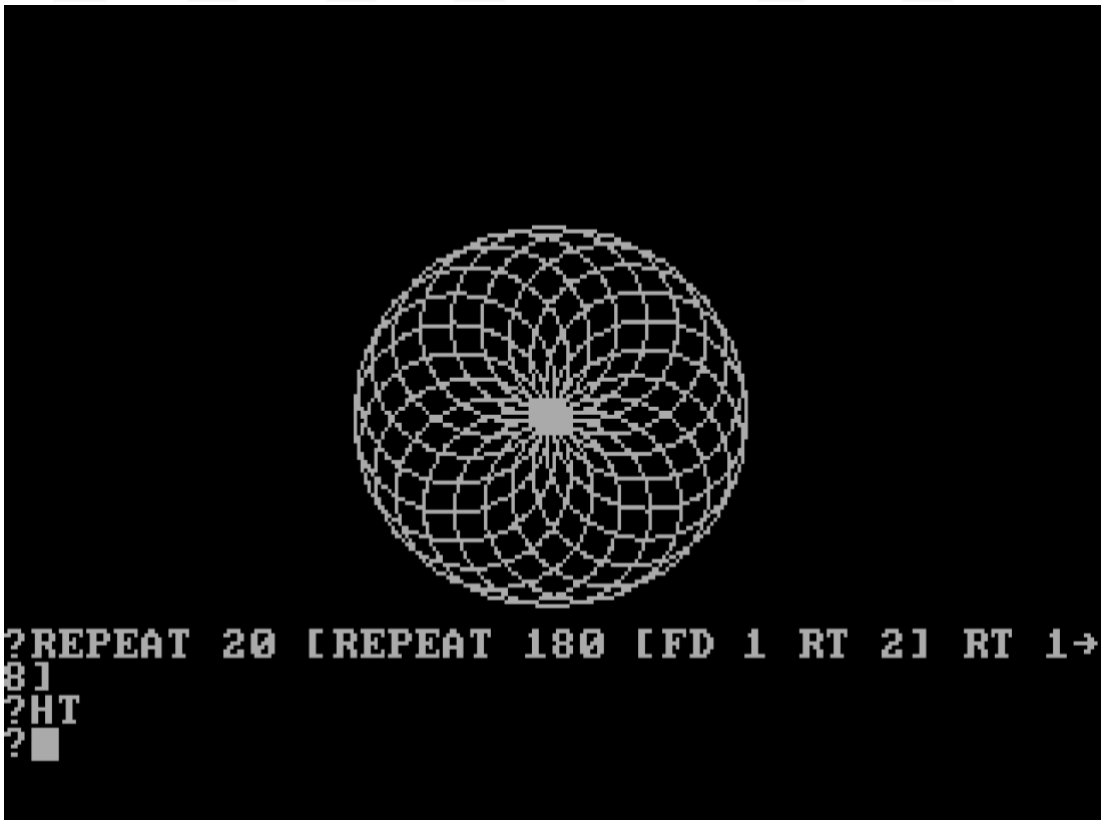

Figure 2.2 : The *LOGO Programming* game - 1967 (Url-2).

Later, the *Oregon Trail* game (Figure 2.3), published in 1974, was the first serious game played in elementary school classrooms for almost two decades during the 1980s, and as a summit point, affected remarkably the serious game trend (Needleman, 2017). This game, representing its genre perfectly and appearing in roughly all serious game-related studies, replicates the challenges of having a pioneer life on the Oregon Trail during the 19th century (Becker, 2007; Bigelow, 1997; Caftori and Paprzycki, 1997; Kane, 2020; Regalado, 2017; Slater, 2017).

Figure 2.3 : The *Oregon Trail* game - 1974 (Url-3).

Back then, during the era of these milestone games for serious games, the target audience for serious games was the children, however, currently, they expand their territory to all ages (Allers et al., 2019; Needleman, 2017).

As stated previously, many fields use serious games to educate their audiences on a specific topic while entertaining them. The historical landscape area properly used serious games to transmit the cultural heritage of a district in the *Fort Ross Virtual Warehouse* game (Figure 2.4). This game immerses the players and supports their consciousness through a virtual cultural environment (Forte et al., 2012; Lercari et al., 2015).

In the urban planning field, the *SimCity* game is one of the most well-known ones (Figure 2.5). The game assigns the settlement development and management of a city with all its dynamics like the economy, energy, waste, etc., to the player (Poplin, 2011).

Figure 2.4 : The *Fort Ross Virtual Warehouse* game (Forte et al., 2012).

Figure 2.5 : The *SimCity* game (Url-4).

Linguistics serves as one of its best samples of serious games with the *Tactical Languages and Culture Training Systems* (Figure 2.6). In this game, the player learns language and culture by communicating and speaking in several foreign languages. The game occurs in the form of different courses using artificial intelligence to serve immersive gameplay. Since the player should be able to communicate and speak to pass the levels, the control of speed and hardness of the education is under the control of the player (Johnson and Valente, 2009).

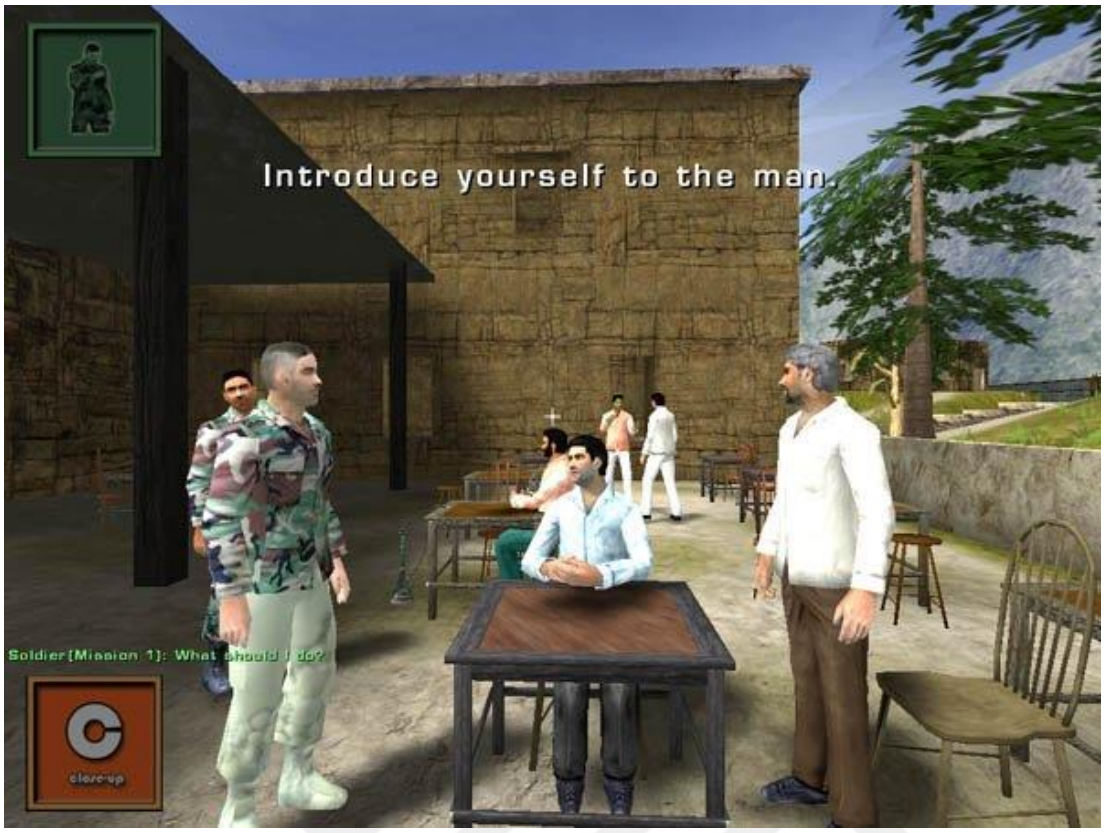

Figure 2.6 : The *Tactical Languages and Culture Training Systems* game (Johnson et al., 2004).

2.2.1 Immersiveness within Serious Games via Virtual Reality and Head-Mounted Devices

Despite the expansion of the serious games compared to the past, they are still underestimated, and players prefer them the least among other digital games. The reason is that the players assume a popular game to be fun to desire playing it (Allers, 2019). The emergence of Head-Mounted Display (HMD) devices increased the immersion of the player generally in all digital game types, especially the entertaining commercial ones, by enabling the players' interaction with a virtual world through the virtual reality experience.

Considering the serious games, they enabled the capability of real environment simulation, creating the opportunity of providing low-cost and riskless learning settings in various domains (Cruz-Neira et al. 2018). Hence, they let the player experience and practice an intended activity or skill repeatedly until being expert enough to try it in the real world (Albar, 2014). Simulation serious games even have great samples in non-VR games like *PULSE* (Platform for Undergraduate Life Support

Education), educating life-supporting skills to medical science students (Cook et al., 2012).

However, the emergence of VR technology maximized the effect of this capability by immersing the player in the intended activity. For instance, in their study, Chittaro and Buttussi (2015) proposed an immersive VR serious game considering the safety of aircraft passengers (Figure 2.7). They stated that despite the pre-flight safety briefings and distributed cards, the passengers do not pay the required attention to them. Such an engaging HMD-based serious game can be effective in the passengers' experience of a possible emergency situation and educate them on how to survive in dangerous conditions (Figure 2.8).

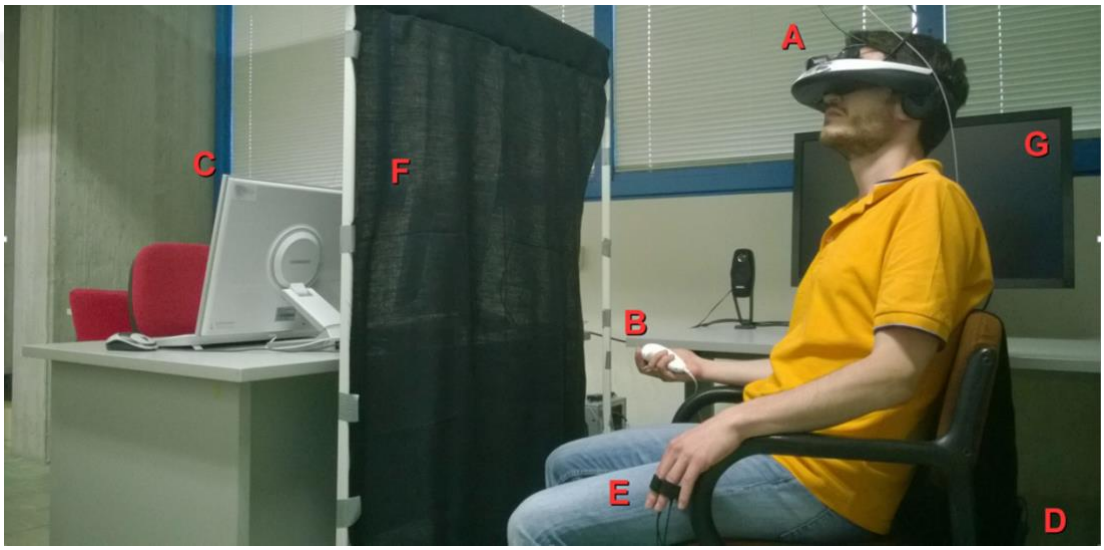

Figure 2.7 : The VR game setting (Chittaro and Buttussi, 2015).

Figure 2.8 : The gameplay experience (Chittaro and Buttussi, 2015).

On the other hand, the integration of VR technology with the gaming industry enabled its advancement through the Metaverse concept. In their article, Dionisio et al. (2013) state that Metaverses are networks of 3D virtual environment integrations that offer a not restricted alternative world of human interaction. Among the reasons for the enhancement of the Metaverse is the innovative nature of gaming. As a result of the concept of the Metaverse, serious games will include more than just virtual landscapes as their environments, and the teaching will take place in the Metaverse itself.

3. VIRTUAL LANDSCAPE

3.1 Virtual Landscape in Digital Games and Other Domains

As stated before, the thesis pointed out the importance of virtual landscapes in the development process of digital games, consequently serious games. It is nonetheless challenging to find a standardized design methodology for the design and production of any virtual landscape in the game industry. Due to these factors, digital game companies implement various methods for each project they undertake, resulting in a significant amount of time and effort spent on each project (Huijser et al., 2010; Kim et al., 2018). Consequently, the virtual landscape design process in the game industry is inefficient, as it lacks a unified and standardized design methodology (Kim, 2019). In contrast, several domains, such as architecture, landscape architecture, and urban planning, have applied multiple design methodologies throughout history, making the process of creating space easier and resulting in higher quality designs. It is unfortunate that the digital game industry lacks such a capability at the present time. In light of this background, a methodological design approach is needed for the digital game industry, which is accessible by understanding and applying the current situation and the solution to the missing parts.

Studies focusing on virtual landscapes are available in the literature; however, figuring out the existing research; notably, all the researchers took advantage of virtual spaces to design a better real space in landscape architecture, architecture, and urban design. The following examples can be found throughout a comprehensive literature review. Through an understanding of virtual space as a tool, landscape architects can visualize concepts or ideas, or architects can archive their designs more efficiently (Portman et al., 2015). The use of 3D virtual environments is a useful tool for duplicating and analyzing real-space gardens in a more accurate manner (Li and Xu, 2020; Wang and ZhenNan, 2010). An automated methodology has been developed for the design of real spaces in order to make the process more efficient (Deussen, 2003). Additionally, two existing studies have attempted to propose a new methodology for designing and presenting the landscape architect's concept more efficiently through the use of virtual spaces (Lammeren, et al., 2002; Lombardo, 2018). A further focus of the researchers is the use of virtual spaces for efficient landscape architecture education. A digital game engine, which is a virtual landscape design tool, is used by Johns and Russell

(Johns and Russell, 2005) as an educational tool for students. Similarly, Francis (Francis, 2001) focused on the observation and preservation of landscape architecture case studies. Additionally, according to the literature, By combining virtual spaces and game engines with Building Information Modeling (BIM) or Landscape Information Modeling (LIM) software, real space can be simulated virtually (Ahmad and Aliyu, 2012; Boeykens, 2011; Döllner and Hagedorn, 2007; Ma and Xia, 2017).

3.2 Virtual Landscape as a Design Area

The existing studies on the virtual landscape emphasize the use of it as a tool to improve the efficiency or quality of real space design. However, real space design techniques have rarely been used to enhance the quality of virtual landscapes. In the field of space design, visionary architecture, which facilitates architects to move beyond the real limitations of space design by visualizing their exemplary ideas virtually (Collins, 1968) provides highly superficial results in order to play a critical role.

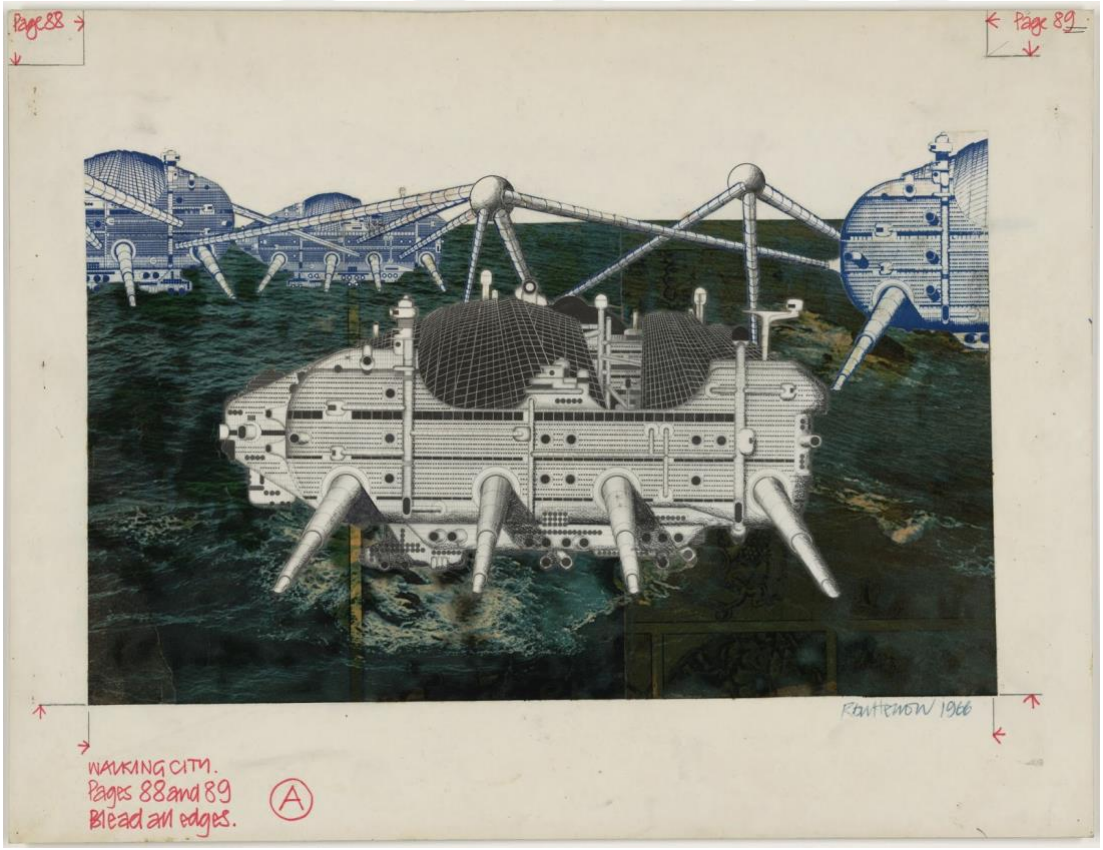

Figure 3.1 : Herron' drawing as a *Walking city* (Ron, 1966).

For instance, Cook and Webb (1999) visualized the Herron as a *Walking City* (Figure 3.1), and Dacosta et al. (1995) presented a vision of urban environments in the future with the work of Antonia Sant'Elia (Figure 3.2). While the outcomes are visual materials that illustrate the architect's abstract concept, the term interactive space would be considered controversial. So, even this example of using a virtual landscape as a design domain does not provide an adequate enhancement of real space.

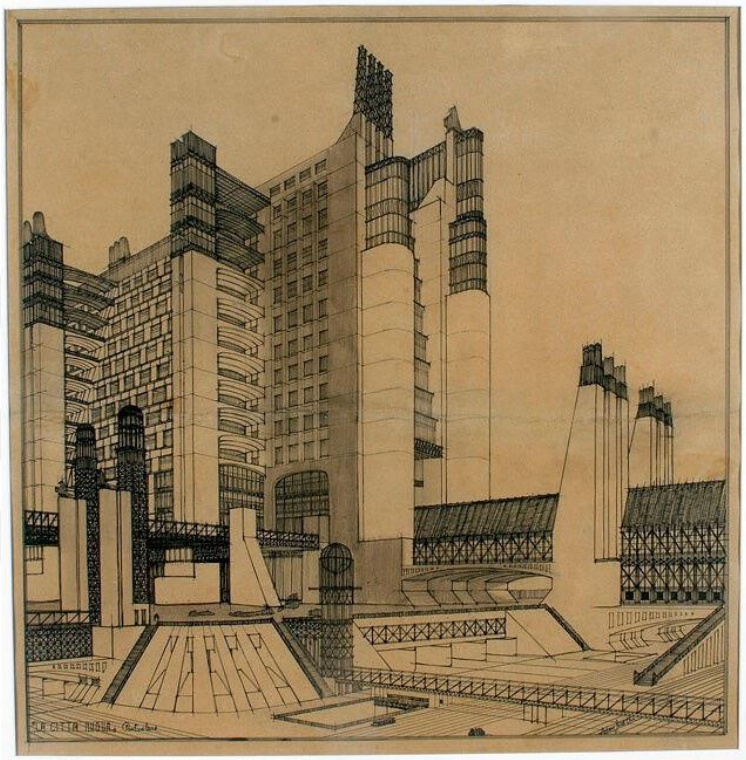

Figure 3.2 : The work of Antonia Sant'Elia (Landes, 2016).

Yet a few studies exist that consider the virtual environment to be an integral part of the design process, including Kim et al. (2018), Kim et al. (2017), and Kim (2019). The purpose of this research series is to enhance the efficiency and quality of virtual environments by adopting design methodologies from the landscape architecture, architecture, and urban planning domains. To provide further detail, the researchers analyzed and compared the differences between real and virtual space as a design domain (Kim, 2016), discovering the classification potential of virtual landscapes based on their attributes. In this research, a classification methodology is first proposed, and then the researcher developed a digital game design methodology (Kim et al., 2018) validated with the comparative experiments and patented in South Korea by Bazin and Kim in 2018.

3.2.1 Virtual Landscape Classification Methodology

Based on the literature, Kim (2017) proposed a method for categorizing digital games named virtual landscape classification methodology. Since each game's characteristics can be defined by the attributes of its virtual landscape (Apperley, 2006), Kim's methodology divides the virtual landscapes of digital games, not the games themselves. This methodology is based on five categories and sixteen variables, in accordance with the principles of architecture, landscape architecture, and urban planning. Table 3.1 presents standards and variables as an overview of the methodology.

Table 3.1 : Virtual landscape classification methodology (Kim, 2017).

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

This classification methodology consists of story, player scale, interaction level, dimension, and space shape principles. Accordingly, depending on the type of digital game, the story can either be *generating* or *representing*. The virtual landscape elements play an important role in designing the virtual landscape in a *representing* story. Contrary to this, the story of the game is not constructed according to the elements of the virtual landscape in the *generating* story type, and the player itself controls the story flow of the game. Regarding the player scale variable, the methodology divided it into three types to determine how many concurrent players are in the game. When a *single* player scale is applied to a digital game, only one player can play the game, but when a *group* player scale is used, two or more players participate simultaneously. Lastly, two or more *groups* can play a massive game simultaneously. About the interaction level, the player may have no environmental elements in the virtual landscape enabled for interaction at a *none* interaction level, may be allowed to interact *partially* with the available elements, or may have the chance to engage with *all* the existing assets in the gameplay scene. The dimension principle is made up of two digits and represents the axes of the virtual landscape as well as the axes of the player's movement capability. The first digit represents the virtual landscape's axes, while the second digit represents the player's movement, both

of which can be *2D* or *3D*. Player movement patterns in the virtual landscape are determined by the space shape and its four variables. The spot shape determines that the player is able to move freely within a specific boundary of the game scene. Same as the *spot* virtual landscape, in the *linear* landscape, the player can move in a restricted area, however, this movement has only a fixed and specified direction. Furthermore, the mixture of spot and linear landscape types generates the *chain* style. Finally, the player can move freely with no restrictions in the *face* mode. Therefore, in the classification process of the digital games' virtual landscapes, the combination of all these variables comes together and generates a six-digit code. This code represents the story, player scale, interaction level, dimension, and space shape of the virtual landscape, respectively, from left to right with their initials.

3.2.2 Virtual Landscape Design Methodology in Digital Games

Considering the architects or landscape architects, due to the difficulty of demonstrating their ideas in the real world, they use highly detailed and time-consuming master plans adapting various methodologies. However, since the idea exhibition and its revisions are much easier in the virtual landscape design, providing sophisticatedly detailed plans is unnecessary and inefficient. Hence, the virtual environment developers could build the environment itself instead of a master plan with the same effort. Therefore, Kim (2018) developed a virtual landscape design methodology for digital games using the virtual landscape classification methodology to allow the game developers to use an abstract master plan in the shape of bubble diagrams to convey their ideas before the development process. This diagram shows the approximate placement of the ideas using the bubbles. The design methodology improves the digital game design development process by providing a shared design language and an approved design procedure for game designers, artists, and developers (Kim, 2019).

Kim's (2019) master bubble diagram consists of five different layers merged together. The professionals work separately on the PAM layer (Player Activity Map), story layer, artificial environment layer, natural environment layer, and media layers and combine them to generate the master diagram (Figure 3.3).

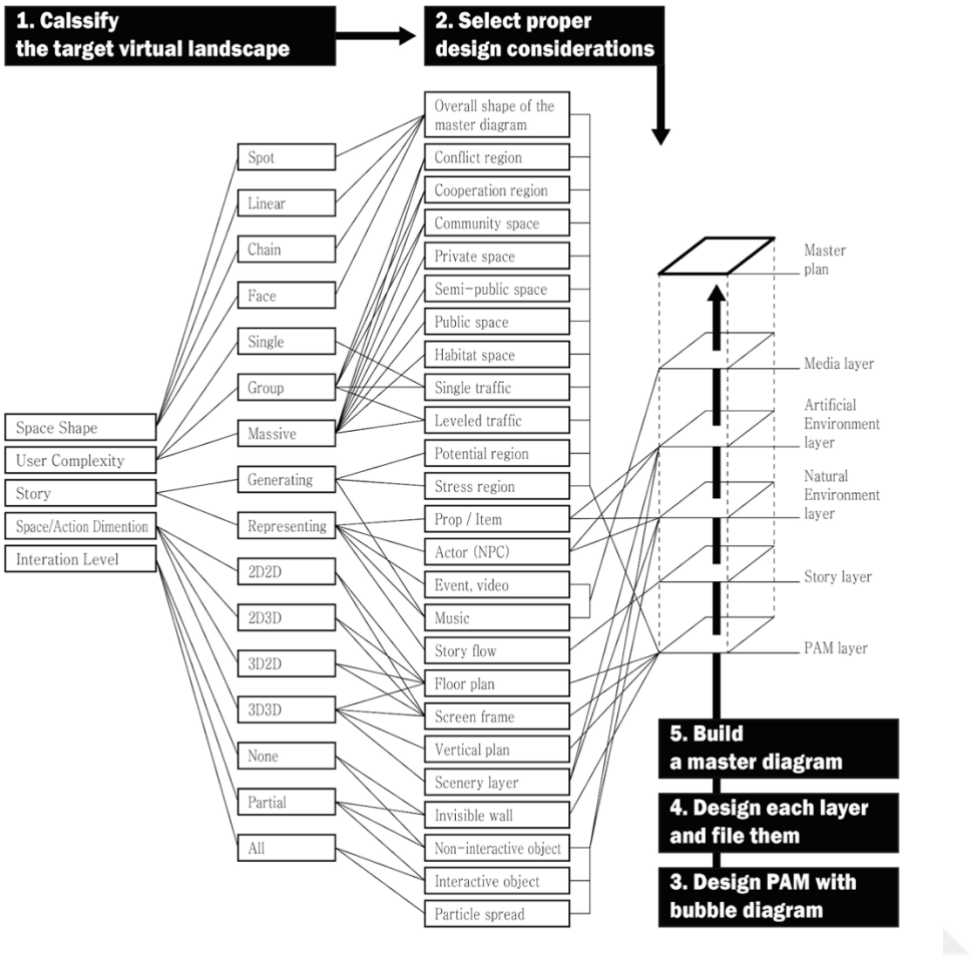

Figure 3.3 : Digital game classification and design methodology (Kim, 2019).

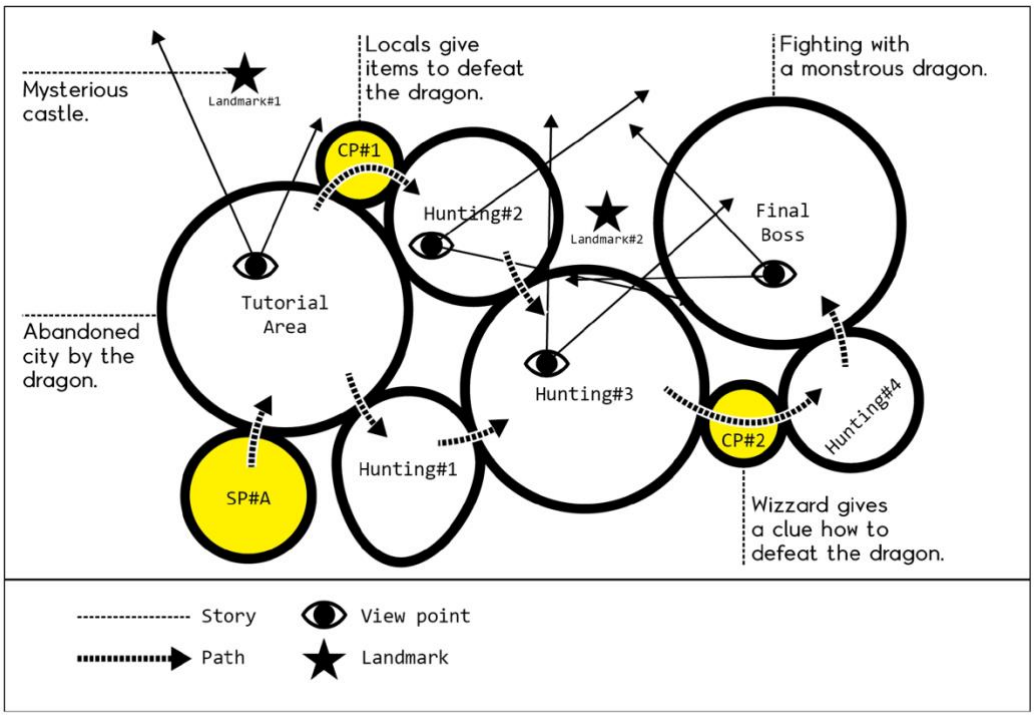

Figure 3.4 : Sample of bubble diagram with a PAM and story layer (Kim, 2019).

Using this methodology, the experts of different required professions could easily verify the placement of the assets and the space's structure. They only need to approximate the size and position of the assets and concentrate on the idea transmission and creating the flow of the virtual environment in the digital game (Figure 3.4).

Using the game classification and game design methodology, this thesis aims to figure out the evolution process of the virtual landscapes within serious games during a specific period and observe its effect on the contents of the games. Afterward, it will use the player's user ratings to investigate the asset distribution balance within different layers in most successful games with partial interaction levels. Hence, it will be able to provide a framework focusing on enhancing player interaction to raise the players' learning rate in serious games.

4. EXPERIMENT

4.1 Purpose and Scope

Education has always been important throughout history, however, its methods have changed due to the modifications in people's lifestyles via the emergence of technology. Serious games are one of the modern education methods and are highly dependent on their constituent virtual landscapes.

The main purpose of this thesis is to enhance player interaction in serious games, leading to a rise in the learning rate during gameplay. Hence, in its first step, it develops five serious games with the aim of figuring out the best ways of developing them and to evaluate the learning rate of the players. Then, it gathers a comprehensive database of existing serious games to end up with a result based on their structure, evolution, and the users' reviews to propose a serious game development framework.

4.1.1 Serious Game Development and Learning Rate Evaluation

Considering serious games as modern methods of education in comparison to traditional textbook systems, it is important to be aware of their effectiveness in the learning process. Due to Hamdaoui et al. (2014), keeping the balance of the ludic elements and educational content of a serious game is the most critical and challenging part of designing them. Hence, while evaluating the advantage and effectiveness of a serious game in the learning process compared to traditional methods of education, the learning rate of the players gains dominant importance (Stege et al. 2011). Therefore, during the process of this thesis, we developed and evaluated various serious games in multiple steps. While as the first step, the thesis sought the learning strategies and effective factors in transmitting the provided data to the players via text-based serious games, then it evaluated the learning rate in them compared to the traditional educational methods. Finally, due to the lack of attention to the provided data in the games, the thesis focused on the immersiveness of the developed games by integrating the 360° photos and videos. At this point, the results of these integrations led us toward understanding the importance of virtual landscapes in serious games. Generally, these developed serious games, either text-based or with 360° videos, revealed an inadequacy of player interaction with the educational content provided during the

game. Within all of these games, the players were reluctant to follow the texts they encountered during the gameplay. Below are respectively the taken steps;

4.1.1.1 The Sericum Via and The Anatolian Journey Games

The *Sericum Via* (Eshaghi et al., 2021), a serious game about Iranian cultural heritage, and the *Anatolian Journey* (Vaez Afshar et al., 2021c), a game with the same theme regarding the Anatolian cultural heritage, are two of our developed serious games considering the caravanserais of the Silk Roads. Both of them are text-based games developed with the *Twine* platform (Url-5). Their content is based on a geolocated database gathered considering various accuracy of the information and generated by locating it in the QGIS.

The *Sericum Via* (Figure 2.9), with a focus on the learning strategies, tried to figure out the distracting factors of the game, avoiding the player from learning. Hence, in this study, we ran a survey accompanied by an open alpha playtest for user feedback assemblage and determination of the target audience.

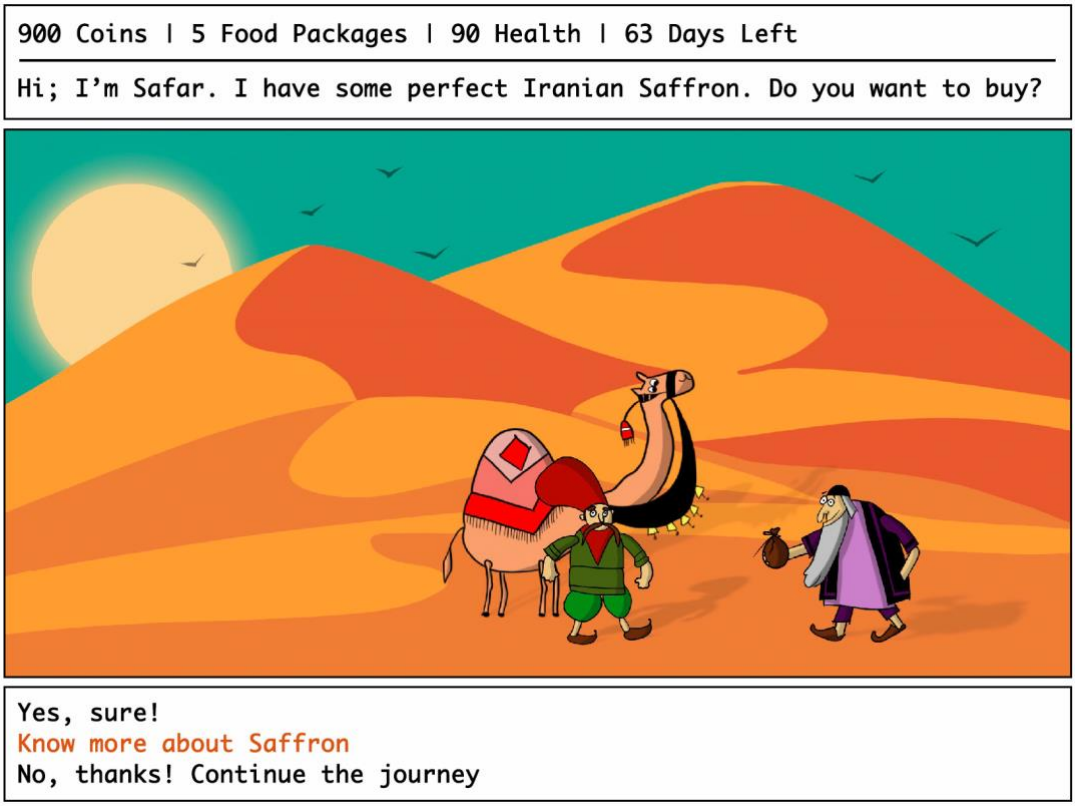

Figure 2.9 : The *Sericum Via* game (Eshaghi et al., 2021).

To do so, we disseminated two sets of questions as Google Forms to players to answer before and after the gameplay. While the first was about the players' previous game

experience and their identifying information, and the second set was concerning the game's feedback. Due to the survey results, the *Sericum Via* needs more interactivity to draw the players' attention to the provided text-based knowledge during the game. The survey results indicate that the players had a limited comprehensive understanding of the game theory.

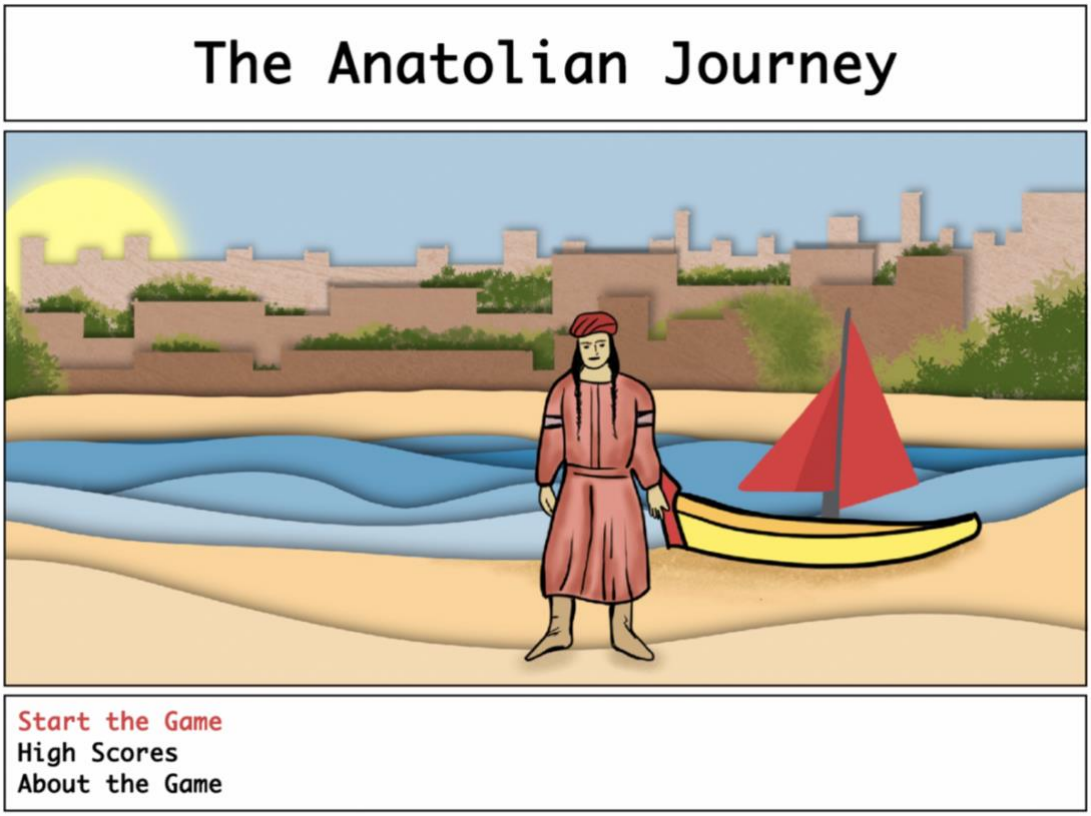

Figure 2.10 : The *Anatolian Journey* game (Vaez Afshar et al., 2021c).

The *Anatolian Journey* (Figure 2.10) considers the previous game's user feedback and evaluates the players' learning rate comparing the traditional educational systems. As in the previous study, we again conducted an open alpha playtest, this time, we evaluated the students' learning rate while playing the developed game and compared it to their apprehension of observing the same content in the traditional method as a textbook. We designed our survey for two groups; group A played the game, and group B read the provided text file containing the same content as texts and images. Then, we designed two different Google Form questionnaires for each group, including the same ten questions. The questionnaires tested the conductors' comprehension rate. The survey results demonstrated that using serious games to provide cultural heritage educational data raises the degree of data retention. Hence, players are able to

memorize the data better while it is in the form of in-game questions rather than in readings.

4.1.1.2 Game-based Orientation (GBO) Tool

Afterward, again using the *Twine* platform, we developed an orientation tool for first-year design students. This game-based tool can be used both online during the pandemic and onsite via QR codes (Figure 2.11). The tool aims to introduce the *Istanbul Technical University*'s Architecture faculty in terms of the campus map and available platforms to the users. Additionally, it educates tactile learners regarding the required definitions, methods, technical tools, and software (Vaez Afshar et al., 2021b).

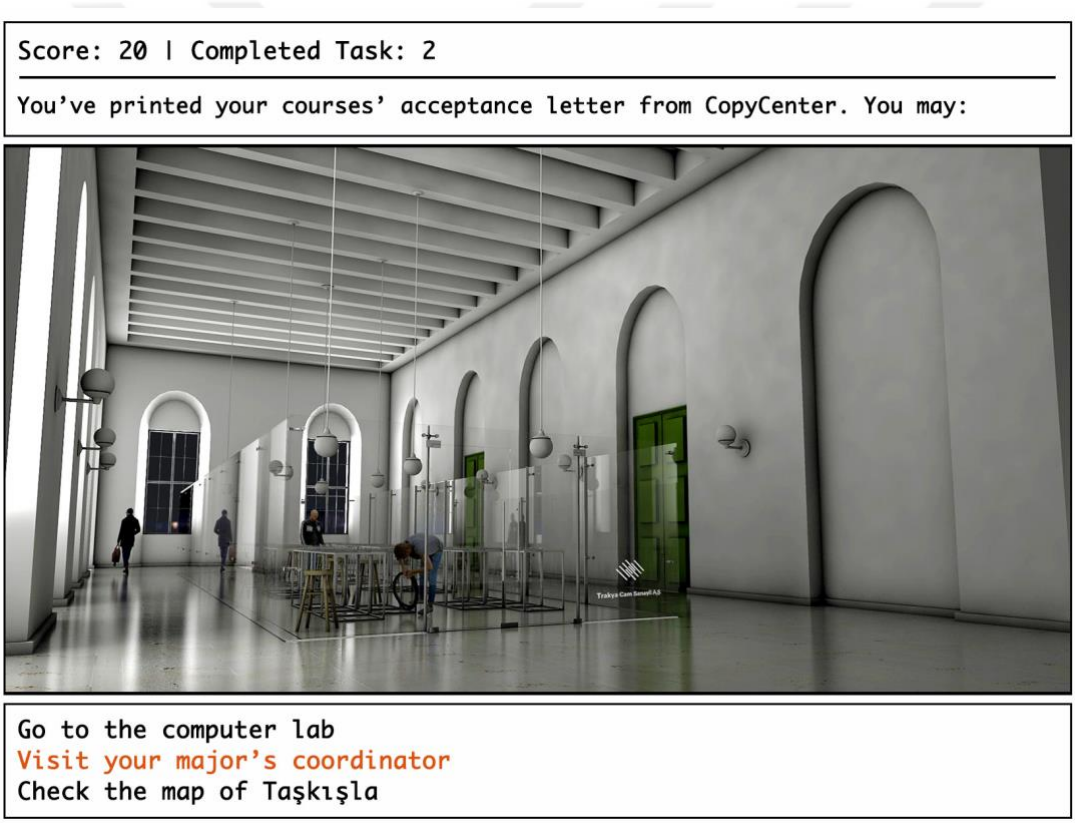

Figure 2.11 : The *GBO* tool (Vaez Afshar et al., 2021b).

4.1.1.3 Su, a Serious Game for Water Management

Following these text-based game experiences, *Su* is a more visually appealing game that we developed with the children's target audience considering the world's water scarcity issue. The fast-growing global population threatens human beings' water accessibility. It carries fatal importance to educate people regarding water management and raise public awareness, especially from childhood. This time we used

the *Stornaway.io* platform for game development and *Animaker* software, allowing animation creation for nonexperts for visual content production (Figure 2.12).

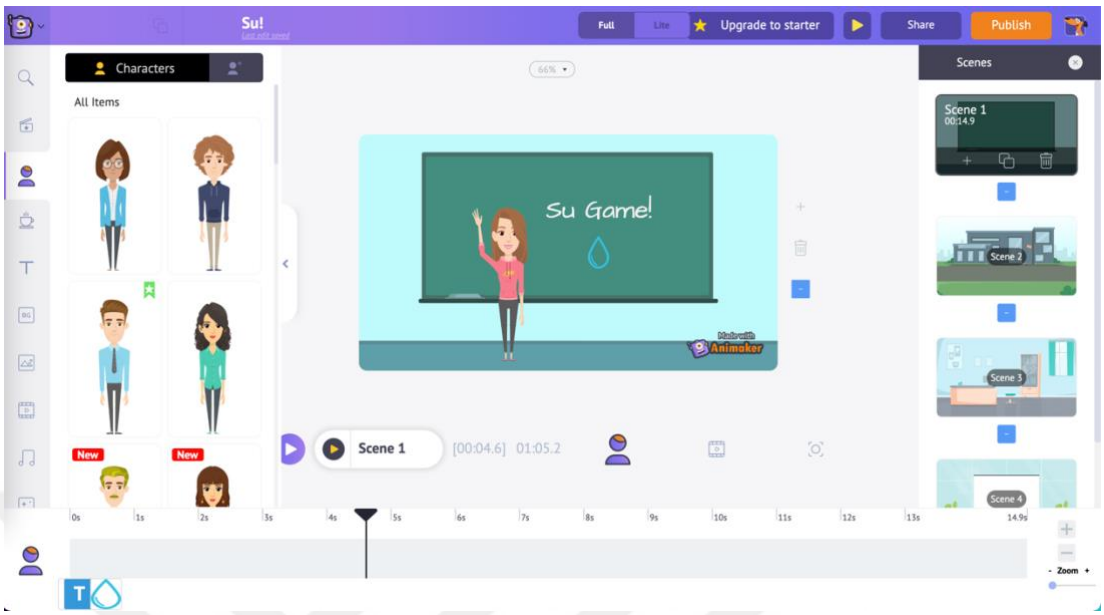

Figure 2.12 : *Animaker* software interface.

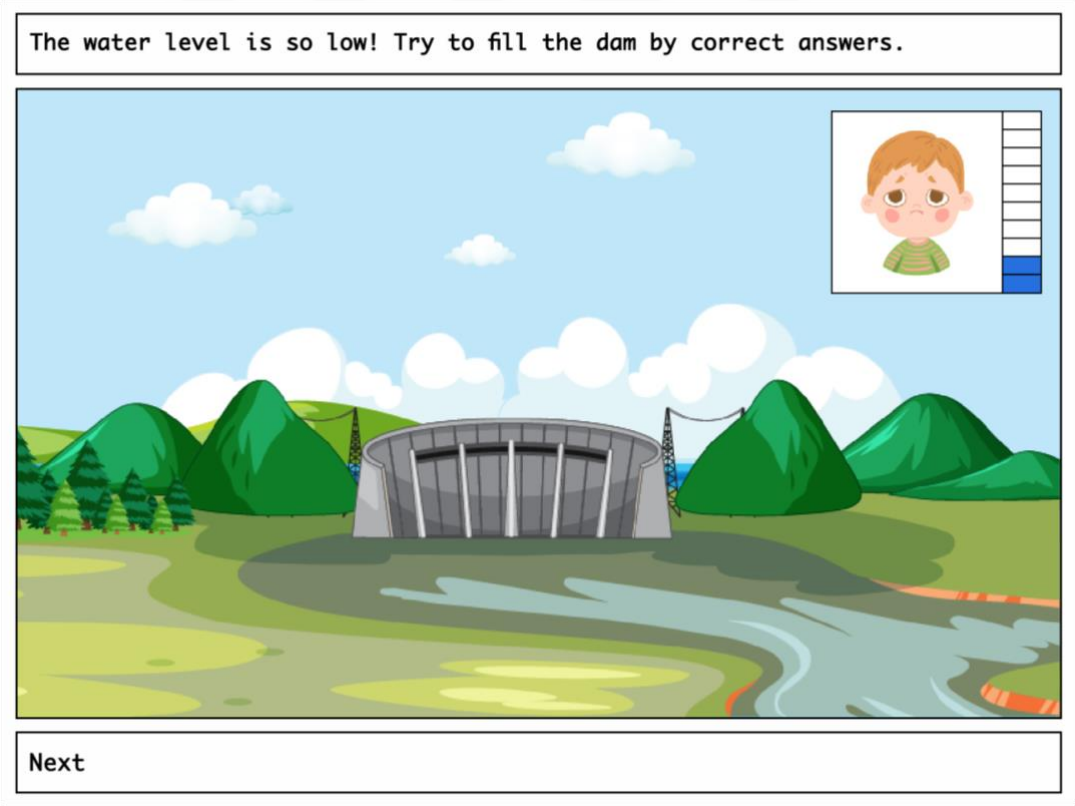

Figure 2.13 : The game environment changes when wrong answers are given.

National Geographic Turkey's 25 Liters: In Pursuit of Water documentary inspired this study on Istanbul's dams' water level. This game, with its nonlinear narrative

presented as visually enriched content, encourages kids to make wise decisions to survive in the drought situation they are facing in the game. It trains the players on the water's importance and its influences on the planet, environment, and landscape (Figure 2.13). By changing children's lifestyles, the study aims to revive the country's in-danger future (Vaez Afshar et al., 2021a).

4.1.1.4 Khan Game

As mentioned previously, throughout the whole steps, we aimed to better the learning rate in our developed games. Hence, in addition to the importance of the immersiveness factor, being user-friendly and low-cost is also critical. In the *Khan game* project, which is the continuation of the *Anatolian Journey*, we aimed for equitable and inclusive education (Figure 2.14).

Figure 2.14 : *The Khan Game* (Varinlioglu et al., 2022).

As a serious cultural heritage game using the 360° images of geographically distributed targeted architectural heritage and using virtual reality headsets, we provided a low-cost and immersive 360° virtual tour of Anatolian caravanserais with engaging narrative and game elements (Varinlioglu et al., 2022). Testing the players' interaction with the various parts of the game via Google Analytics led us to wonder more about the role of the constituting virtual landscapes in serious games and their influence on the players' learning rate (Figure 2.15).

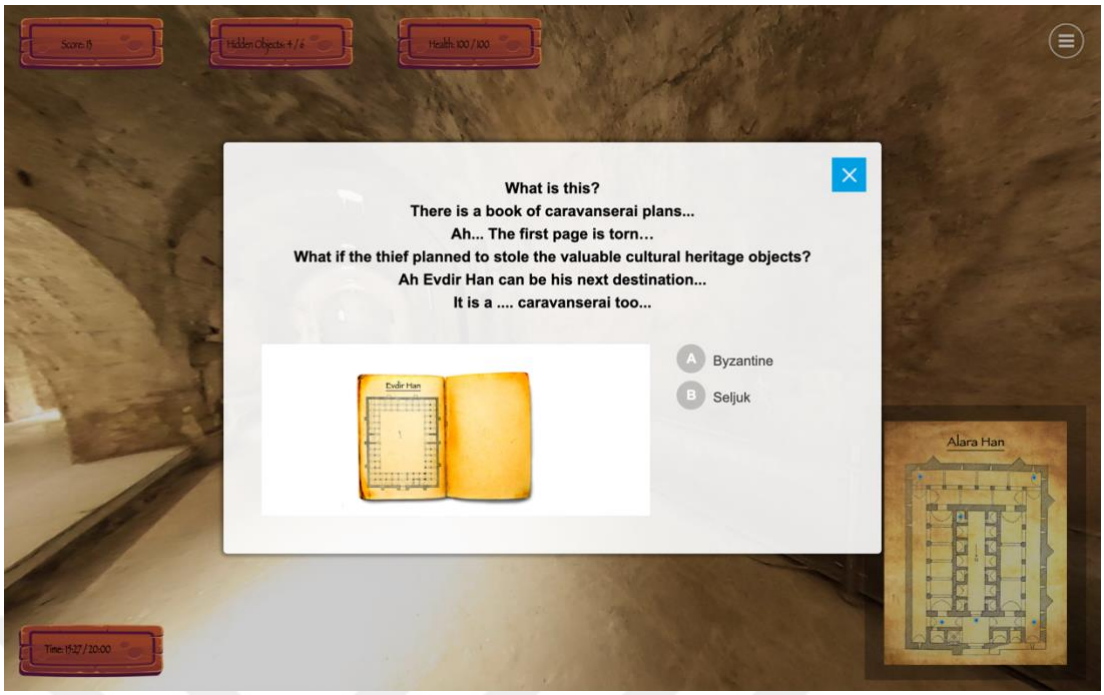

Figure 2.15 : A sample question in Khan Game (Varinlioglu et al., 2022).

Hence, due to all the mentioned steps of the thesis and the previous experience with serious games, the thesis reaches the point that it needs a deeper investigation of the virtual landscapes and their role in digital games.

4.2 Serious Games' Database

During the thesis's steps, for the sake of its ultimate aim, we gathered a database of serious games to analyze their virtual landscapes' chronological change patterns to their role in the evolution of the serious games.

4.2.1 The Structure of the Database and its Classification

To gather and analyze the existing serious games, we used the Steam video game digital distribution service, one of the most comprehensive game platforms. We filtered the existing digital games in Steam with the education tag to include all the serious games in our pool, ending in 2531 entries. We added the game tag to our search criteria, and the number increased to 1102 serious games. Exploring the games, we eliminate some irrelevant contents to ignore non-educational games and unsuitable ones in terms of content. Hence, the final number reached 702 digital games. Afterward, we created an Excel sheet, transmitted the games' introduction information, like their release date, content, and whether they support HMDs or not,

and sorted them based on their dates. The time spectrum of this database is from 1992, the oldest date in the gathered games, to 2020. We also added a simulation row to the table to demonstrate whether they are simulation games or not, meaning simulating a real-world activity (Jounes, 2013). While Table 4.1 indicates a summarized version of the database, and the Appendix A provides the full raw database.

Table 4.1 : The summarized version of the gathered 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	Kid's Learning	RSN22S

As a showcase, the game *Discovery Tour by Assassin's Creed: Ancient Egypt*, published in 2018 by *Ubisoft* as a serious game, conveys historical content as its core topic (Figure 4.1).

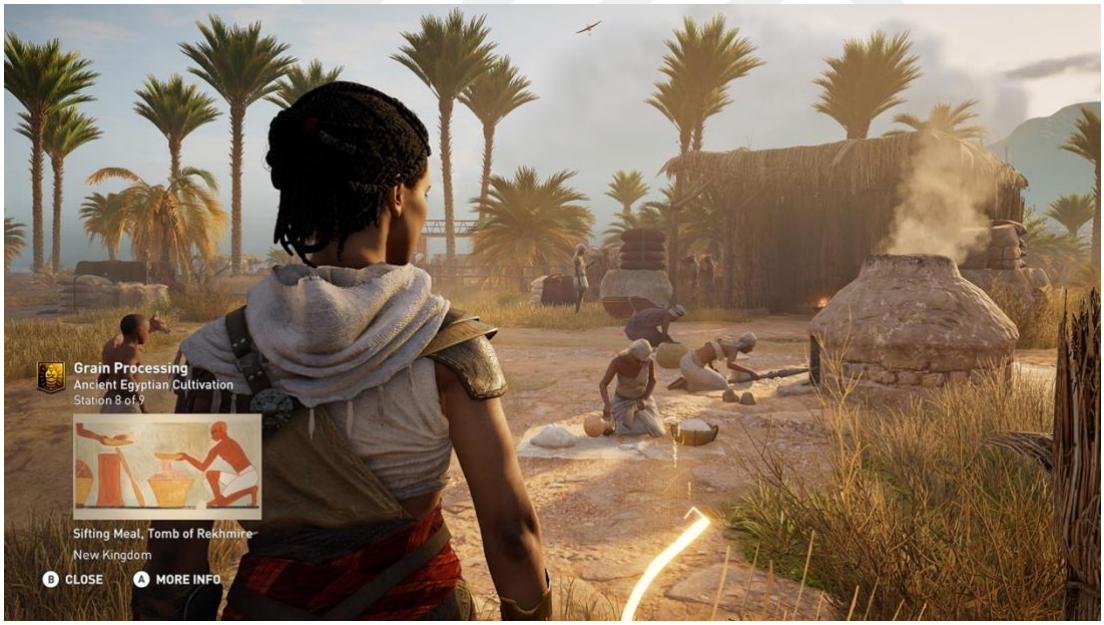

Figure 4.1 : *Discovery Tour by Assassin's Creed: Ancient Egypt* (Url-6).

This game, which can be described as a living museum, transmits information regarding the ancient Egyptian lifestyle, customs, and habits to the player by allowing him/her to inspect the world with no distribution. The game is known as a *walking simulator* genre, enabling the player to explore the environment along with a set of notes (McCree, 2020). Classifying its virtual landscape, it has an *RSP33F* classification code, declaring that its story is *representing*, its player scale is *single*,

partially interactive, and has a *3D* environment enabling free movement in three axes for the player. Remarkably, its space shape is *face* and does not restrict the player with a specific boundary, which is very rare among the whole database.

To be able to manage the data for reaching an apprehendable result, we divided all 702 games into separate Excel sheets based on their publication years. It enables us to generate pie charts demonstrating the distribution rate of various answers in each column for all the years separately. The tables and pie charts of each year have been generated, which will be given later, accompanied by a heatmap. Afterward, we generated the final statistics Excel sheet using the graphs. This sheet demonstrates each column title's number or percentage for all the years. To understand the changing pattern, we generated a heatmap that revealed the most and least numbers. Hence, we transferred them to bar and line charts, considering only the three most shown subjects and classification codes. The full yearly raw data, enhanced by the heatmap, is given in the appendices part, Appendix B.

4.2.2 Analysis and the Growth Patterns of the Database

The research results reveal that the number of serious games has a yearly increase during 1992-2020, except for a few decreases during all times. While from 1992 till 2013, only a maximum of three serious games was released yearly, it increased to 11 games in 2013. Additionally, the biggest shift occurred in the year 2020, the start of Covid 19 pandemia. Since 271 cases were developed this year, the percentage rise is 188.2% according to 2019 and 2363.6% compared with 2013 (Figure 4.2).

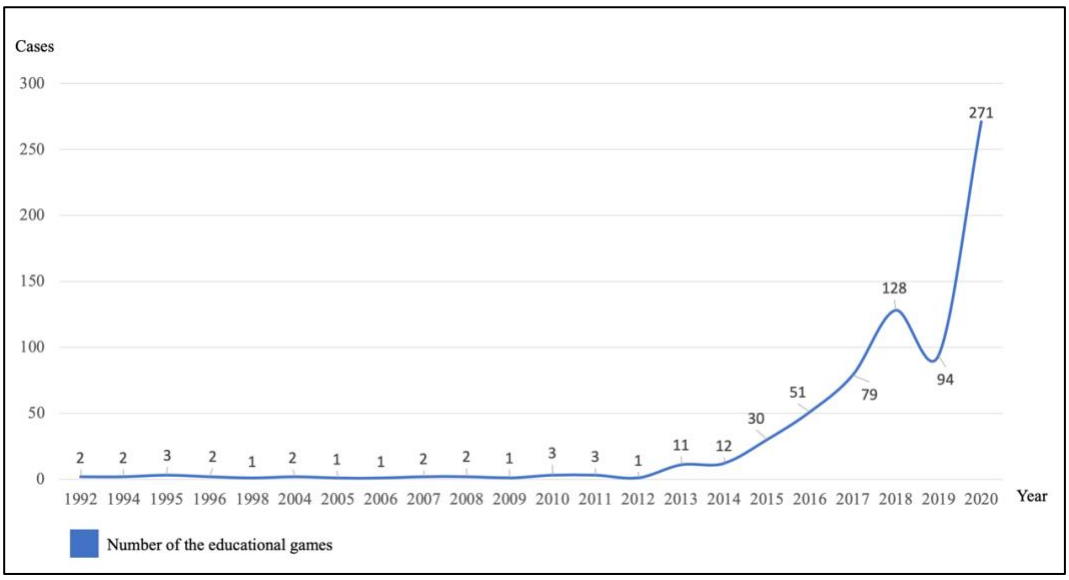

Figure 4.2 : Number of serious games on the Steam database (1992-2020).

The option of compatibility with HMDs and providing a VR experience was added to serious games for the first time in 2012. 18.1% of the games released in 2020, 49 cases, have the capability of being played with HMDs. This number is equivalent to the total number the HMD supporting games till 2019 since their emergence (Figure 4.3).

Our analyses regarding the contents which the serious games educate reveal that the topics turned to more complicated ones during the time. While the serious games appeared with the kids' learning topics in 1992, as time passed, the HMDs' emergence led to the expansion of serious games through the domains like history, general science, and programming. From 2018 to 2020, the puzzle and mind games are the forerunners, respectively, with 10.9%, 8.5%, and 15.1%.

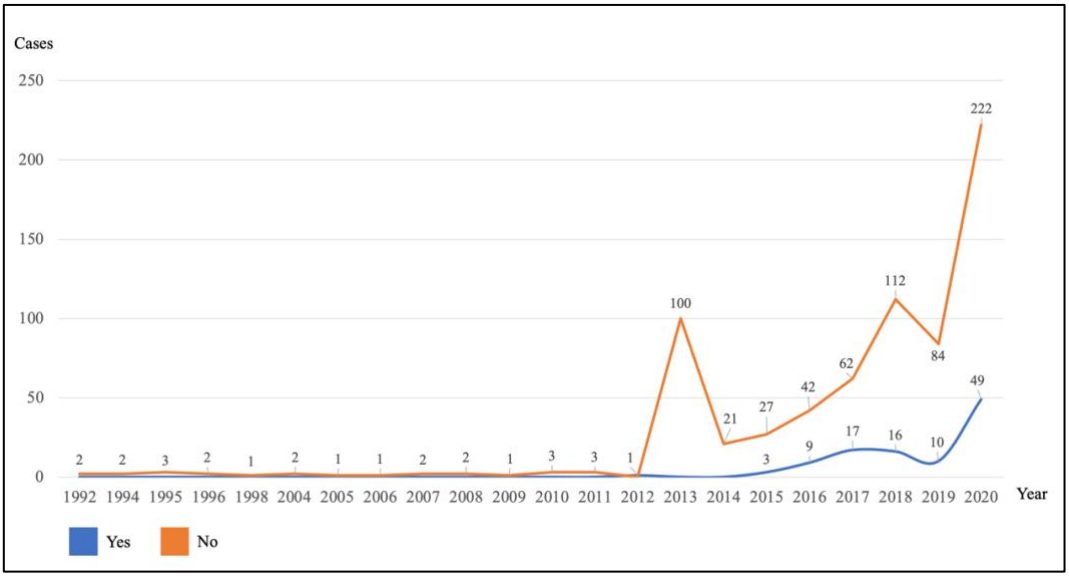

Figure 4.3 : Number of serious games compatible with HMD (1992-2020).

The shift in the use of HMD technology after 2012 led to a significant shift in the category of simulation serious games. Exploring 2020, it is shown that 32.5% of that year's games, 88 cases, are simulation games, even over the total simulation games published between 1992 and 2019 (Figure 4.4).

The results regarding the virtual landscape classification of the games spot growth in the number of games with *generating* stories. Since in the games with a *generating* story, the player is able to engage with all the elements of the virtual landscape and is not restricted by a limited and predefined story, it needs more consideration during the design and development process. Hence, this makes the game development process more complicated in serious games. Despite the effort of developers in manipulating the players' actions and behaviors in the *generating* game space, it is harder than

developing a *representing* game space. Additionally, it fits most serious games to have a *generating* story rather than *representing* (Figure 4.5).

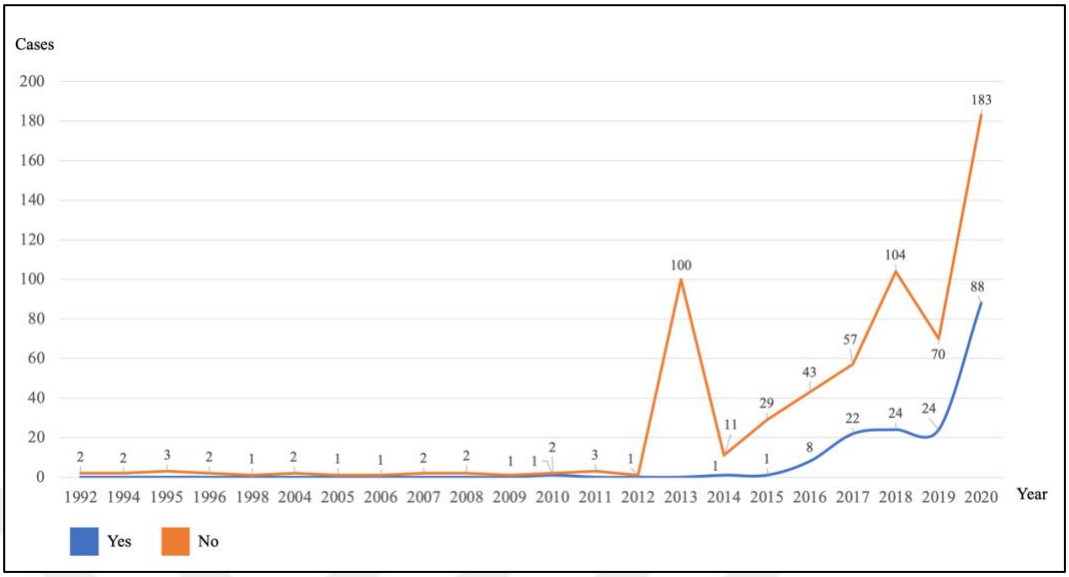

Figure 4.4 : Number of simulation serious games (1992-2020).

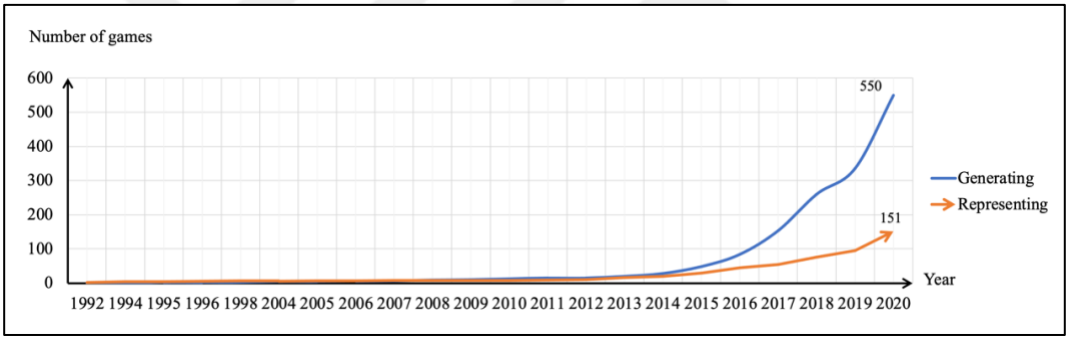

Figure 4.5 : Story principle's variable growth in serious games (1992-2020).

According to the results, during the time, the number of games with a group player scale increased, however, the serious games still have a huge gap in the massive player virtual landscape games (Figure 4.6).

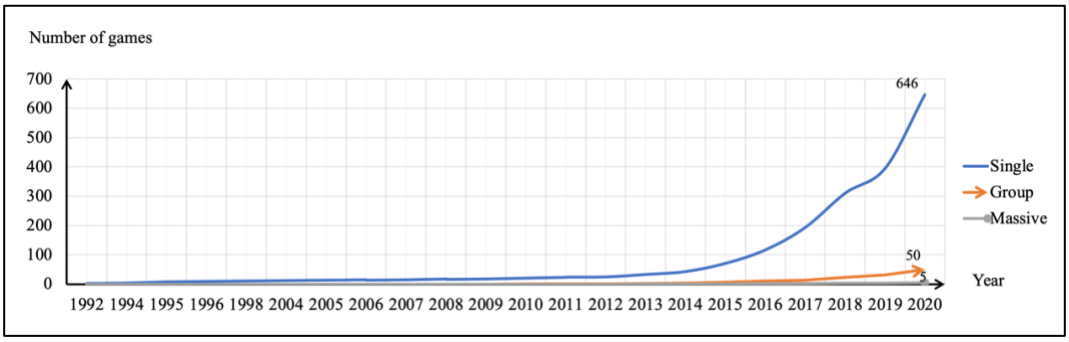

Figure 4.6 : Player scale principle's variable growth in serious games (1992-2020).

Regarding the interaction level, which is the focus point of this thesis, most of the investigated games have a *none* interaction level. However, in recent years, after 2015, *partially* interactive games have appeared and are increasing in number. Contrary, it is still very challenging to find a serious game with an *all* interaction level of the virtual landscape (Figure 4.7).

On the other hand, while generally, the number of serious games and the contents they convey via the virtual landscape is increasing, their quality is still underestimated and not well-developed. To exemplify, while *partially* interactive or *non-interaction 2D2D* games are among the most published game types, they are also very simple to develop (Figure 4.8).

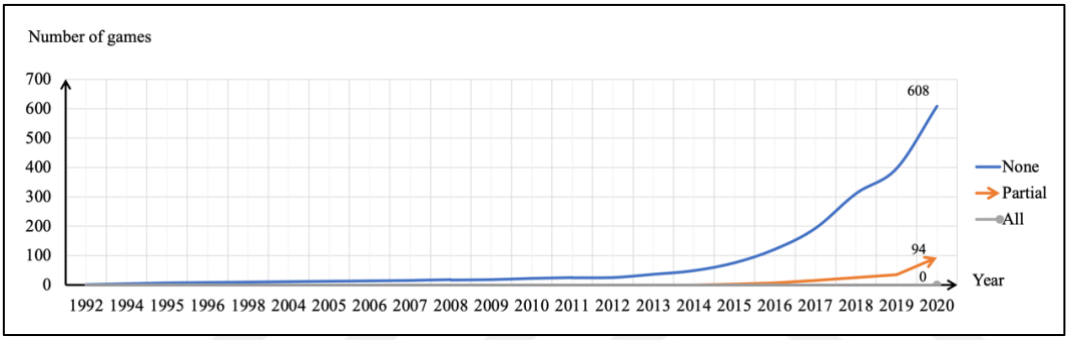

Figure 4.7 : Interaction level principle's variable growth in serious games (1992-2020).

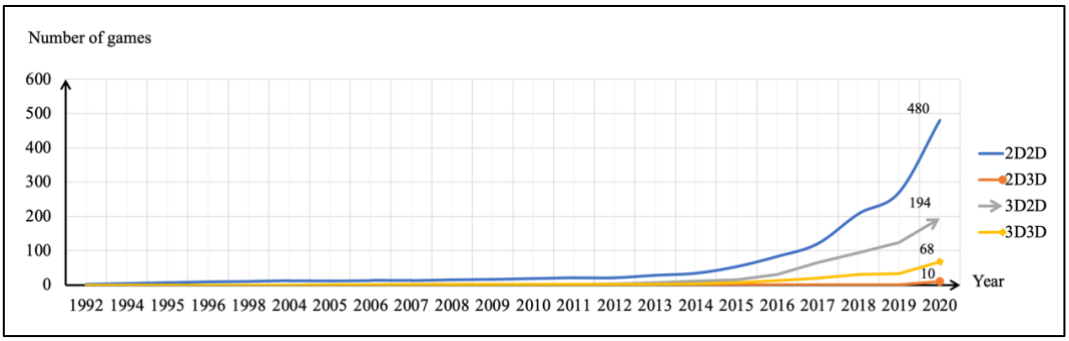

Figure 4.8 : Dimension principle's variable growth in serious games (1992-2020).

Additionally, the results declare a remarkable rise in the games with *chain* and spot virtual landscapes, however, the *face* space is very rare among the classified virtual landscapes' of the serious games in this database (Figure 4.9).

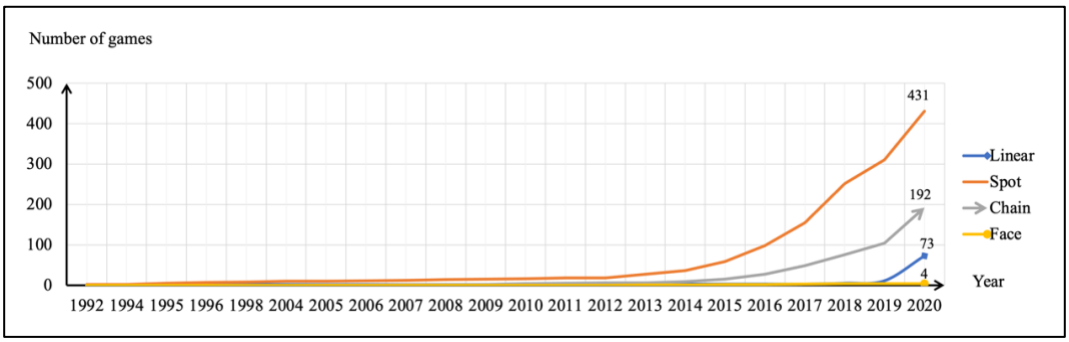

Figure 4.9 : Space shape principle's variable growth in serious games (1992-2020).

Classifying all the gathered games and visualizing them via various charts led us to remarkable results regarding the gradual changes occurring in the serious games' virtual landscape over time. We spotted their compatibility with HMDs, their simulating features, and the relation these variables have with the type of the virtual landscape and the content the games have been transmitting. However, in this part of the thesis, the study adds a new attribute named the user rating and uses the reverse engineering methodology to figure out how the assets existing in the virtual landscapes of the best serious games based on the players' opinions are distributed and compare it with the distribution pattern of non-educational digital games' assets.

4.3 Reverse Engineering of Virtual Landscape in Serious Games

After classifying the virtual landscapes of the games via the game classification methodology, in this step of the thesis, we used the game design methodology to reverse engineer the games to understand their structure. Hence, the study aimed to reverse engineer the five best digital games ever and the five best serious games from the database to compare to provide a framework for serious game development. Reverse engineering is used to segregate the games into their components. Hence, while selecting the digital games for reverse engineering, we considered the research's focus on the virtual landscapes and chose games that strongly emphasized that aspect of the game.

As mentioned, regarding the five best serious games, we added the user reviews attribute of the *Steam* platform into our data set and selected the best games based on it. Due to the implemented sorting, we selected three games with *overwhelmingly positive* reviews and two games with *very positive* reviews. Since any game with a *full interaction level* does not exist on the list, we selected the games among the *partially*

interactive ones due to the focus of the thesis on the player interaction level (Table 4.2).

Table 4.2 : The selected best five serious games.

#	Game Title	Year	HMD	Simulation	Subject	Classification Code	Interaction Level	Review Grade
1	Into The Flames	2020	No	Yes	Firefighting	GSP32C	P	Overwhelmingly Positive
2	The Sapling	2019	No	Yes	Life Simulator	GSP32F	P	Overwhelmingly Positive
3	Discovery Tour by Assassin's Creed: Ancient Egypt	2018	No	Yes	History	RSP33F	P	Overwhelmingly Positive
4	Aerofly FS 2 Flight Simulator	2017	Yes	Yes	Flight Simulator	GSP33F	P	Very Positive
5	Kerbal Space Program	2015	No	No	Space	GSP33F	P	Very Positive

To reverse engineer these chosen games, the research considered each game's first level and tutorial to be played. Because they are places for beginners, logically, we could assume that the most effort is put into those parts by the designers. We also observed gameplay videos in popular and professional gamer community hubs like *Twitch* and *YouTube Gaming* or explored the existing videos and information in Steam provided by the developers. In this step, the digital game design methodology is used to classify all game elements as part of the story, natural, artificial, and media layers. To be precise, it would be better if we could approach the raw data of the games and count the number of assets and effects. However, since these data are protected as the developers' property, it was impossible to approach them. Hence, we took four screenshots of each game's first level for doing such a classification and counted the assets manually. We focused on the parts with the most available elements while taking the screenshots. In subsequent steps, we signed and coded all the elements in the scene based on their titles and layers. Then we created a comprehensive table specifying each game's layers, categories, asset codes, types, names, interactions, details, and image file numbers. Following this, firstly, we analyzed the ratio of assets in each layer. Then, we calculate the interaction level of each game based on the possibility of the player interacting with each asset.

As an example, Figure 4.10 demonstrates the coded screenshots of the *Discovery Tour by Assassin's Creed: Ancient Egypt* game which the thesis mentioned before.

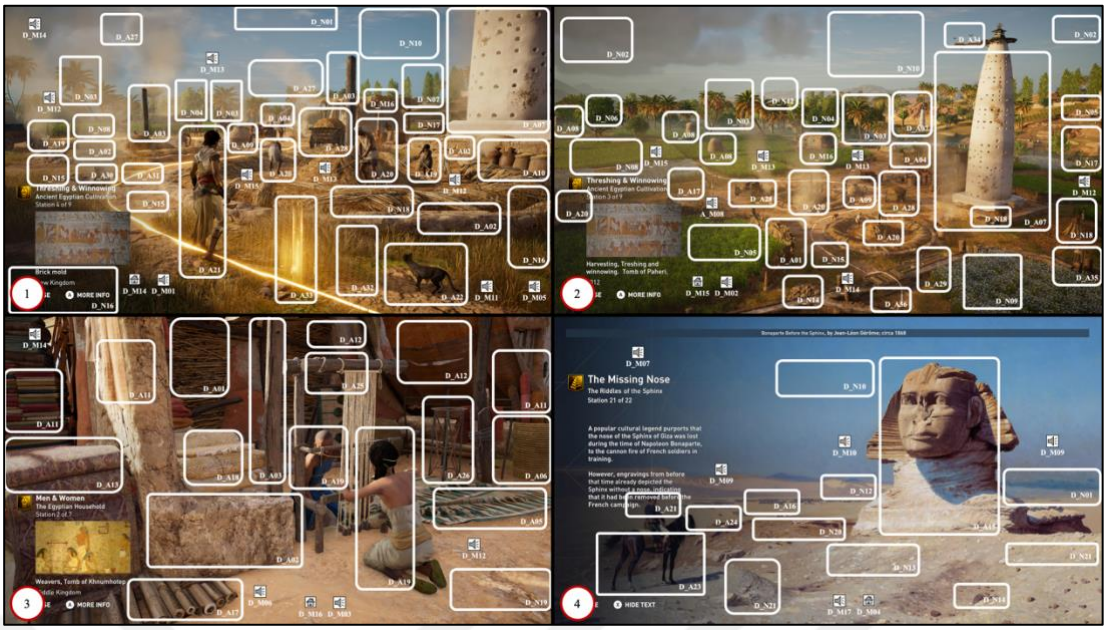

Figure 4.10 : *Discovery Tour by Assassin's Creed: Ancient Egypt* game analysis.

Based on the conducted analysis, this game had put its major focus on the artificial environment layer, with 49.3% of its assets used there (Table 4.3). Additionally, the player can interact directly with 65.8% of its constituting assets (Figure 4.11).

Table 4.3 : *Discovery Tour by Assassin's Creed: Ancient Egypt* game's asset distribution.

Layer Name	Number	Percentage
Natural Environment	16	23.9
Artificial Environment	33	49.3
Media	14	20.9
Story	4	6.0
ALL	63	100

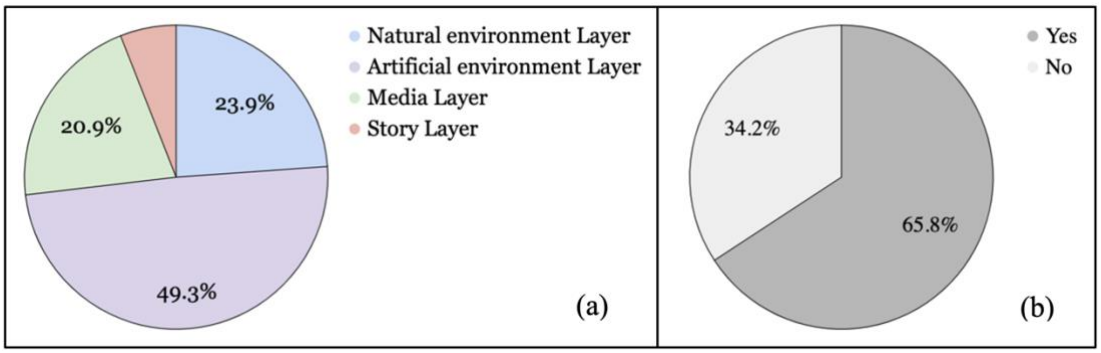

Figure 4.11 : The *Discovery Tour by Assassin's Creed: Ancient Egypt* game: (a)Asset distribution. (b)Interaction level percentage.

The detailed tables of each game, besides its graphs and coded images, are given in the appendices (Appendix C). However, Table 4.4 demonstrates the number of assets in each game's various layers and the interaction percentage of the games.

Table 4.4 : The result of reverse engineered serious games.

#	Game Title	Layer Name				Interaction (%)
		Natural Environment	Artificial Environment	Media	Story	
1	Into The Flames	18	28	14	4	53.30
2	The Sapling	30	2	10	4	52.40
3	Discovery Tour by Assassin's Creed: Ancient Egypt	16	33	14	4	65
4	Aerofly FS 2 Flight Simulator	17	21	14	4	30.80
5	Kerbal Space Program	14	41	15	6	38.90

Investigating the outcomes regarding the serious games with the best reviews by the players, it is observable that four out of five of them are simulation games. Analyzing their classification code, we can see that all of them have a generating story type, except one. While all of them are single-player games, this may demonstrate that it is still challenging to develop serious games with massive or group player scales, which the players prefer. The dimension part of the codes reveals that players rate serious games with 3D virtual environments the most. Finally, the most notable result could be the space shape of the best games. While amongst the 702 games in the database, the face is the least encountered type, all of the five best games have this type of space shape.

Regarding the reverse engineering part, it is visible that the developers put the most effort into the natural and virtual environment layers, and the majority of the assets are in these layers. On the other hand, the media and the story layers are underestimated and get less attention. Considering the interaction level of the assets, even in two of the five best serious games due to the players, less than half of the assets are available for the players' engagement, and the rest are not changeable by the user.

4.4 Reverse Engineering of Virtual Landscape in Digital Games

After reverse engineering these serious games, the thesis implements the same process for the best commercial digital games to determine their success criteria and use it to propose the serious game development framework. To do so, we selected the five best digital games based on the *IGN* database, providing the top 100 video games of history (Url-7). Since the dataset includes games for various platforms, we selected the games randomly among the ones published after 2010 without considering their platform. Table 4.5 demonstrates the selected best digital games, and the full raw data is given in appendices (Appendix D).

Table 4.5 : The result of reverse engineered best digital games based on IGN.

#	Game Title	Classification Code	Layer Name				Interaction (%)
			Natural Environment	Artificial Environment	Media	Story	
1	Journey	RGP33F	9	17	13	3	59
2	Diablo 3	RGP32S	35	28	11	21	73.6
3	The Last of Us Remastered	RSP33C	8	21	14	6	65
4	Grand Theft Auto V	RMP33F	16	33	14	4	66.70
5	Fortnite	GMA33F	33	12	23	11	66.20

To explain more in detail, the thesis provides the coded screenshots of *The Last of Us Remastered* (Figure 4.12) as a sample of a representing game and *Fortnite* (Figure 4.13) as a generating one.

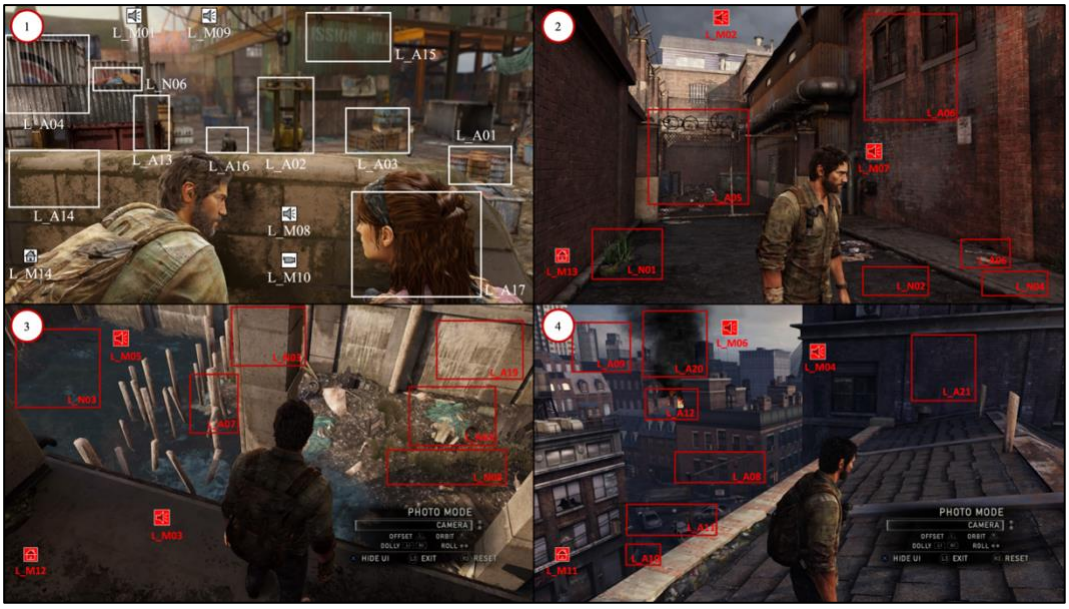

Figure 4.12 : Coded screenshot of *The Last of Us Remastered* game (2014).

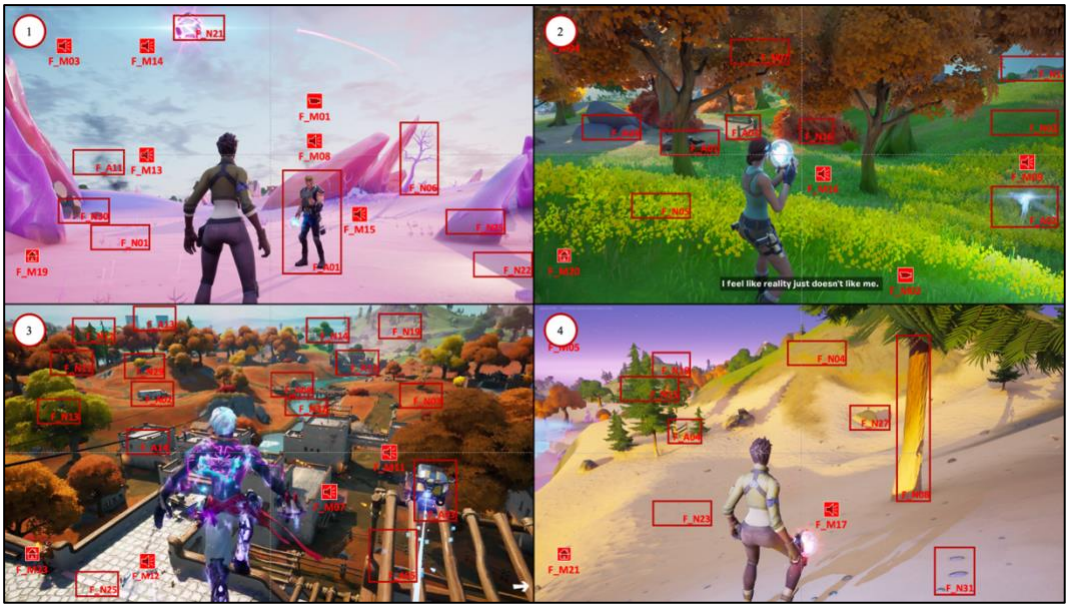

Figure 4.13 : Coded screenshot of the *Fortnite* game (2017).

Figure 4.14 shows their asset ratio in each layer, illustrating how certain elements dominate each layer. As an example, The Last of Us Remastered game's analysis shows the assets are mostly focused on the artificial environment layer, with 42.9%, and the Fortnite game focused its assets on the natural environment layer, with 41.8%.

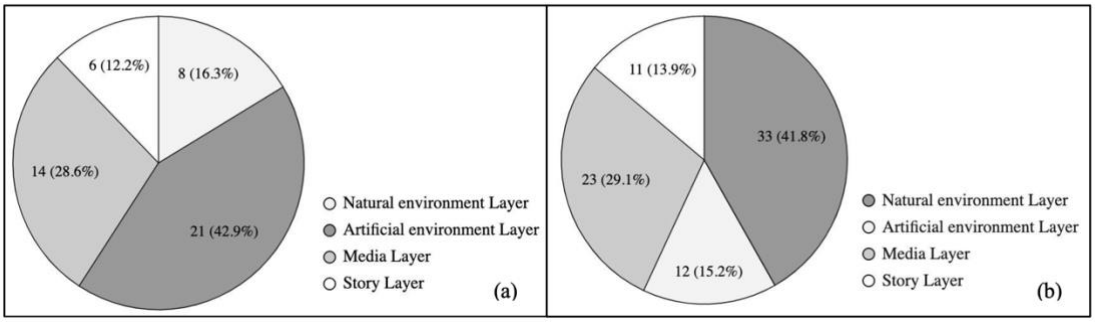

Figure 4.14 : Asset ratio: *The Last of Us Remastered* game (a). *Fortnite* game (b).

The Validation of the classification results for the best digital games and their comparison with the serious games exposes some similarities and differences among them. In contrast to the serious games, the story principle is *representing* in four out of five games. It shows that the players have more chances to influence the story and the game flow in serious games. The player scale principle is also totally different in these two types. Despite the serious games, we can observe *massive* and *group* games as the most successful commercially best digital games. Regarding the interaction level, the *Fortnite* game is the only *all-interactive* game among these ten games. The dimensions have the same results in this investigation, too, with having all the games in *3D*. Finally, the space shape again assigned the *face* variable as the most preferred type.

The reverse engineering of these games also has the same result regarding the asset distribution ratio among the layers. Again, most of the assets are located in the natural and virtual environment layers, and the story and the media layers have the least number of elements. However, we can see that the commercially best games have more interactive assets in their layers, hence having a higher interaction level percentage.

4.5 Findings and Serious Game Development Framework

As mentioned, the ultimate goal of this thesis is to provide a framework for serious game developers to enhance the virtual environment of the games and increase player interaction with a focus on the player learning rate (Figure 4.15). Hence, we reached

plenty of results along with the conducted investigations, including gathering a database of available serious games, classifying their virtual environment with classification methodology, and reverse engineering them using digital game design methodology. Assembling all these data, the thesis seeks to provide a road map for digital game developers, especially serious game developers.

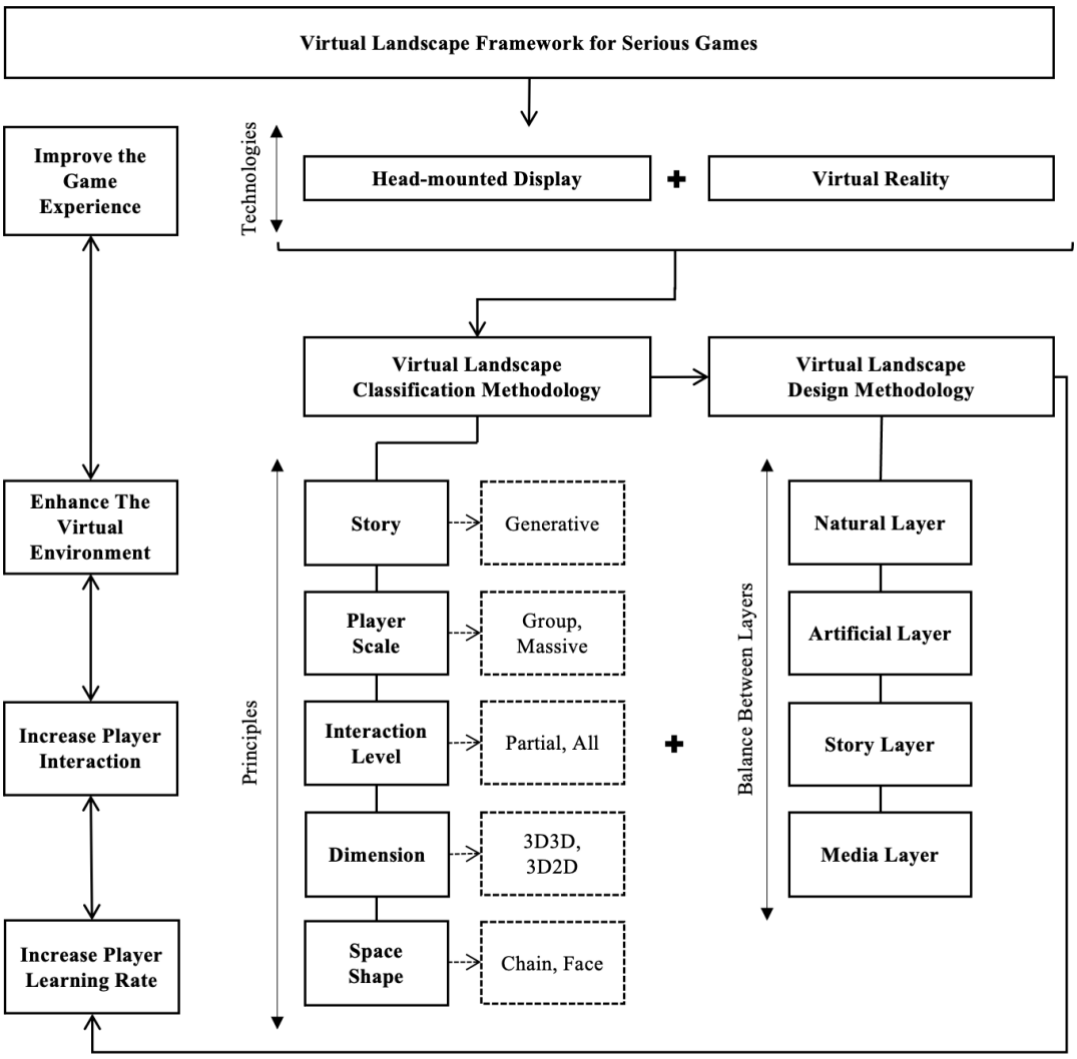

Figure 4.15 : Serious game development framework.

According to the investigations, in general, the number of serious games is getting more and more, specifically after Covid. Hence, with the integration of technology and the Internet into humans' lifestyles more than ever, serious games will get more important day by day. While the number of games supporting HMD technology is increasing, it still has the potential to be worked on and enhanced more. With the enhancement of the VR experience via the emergence of the HMDs, simulation games started to be expanded more than ever. They are able to replicate conditions not easy

to experience in the real world and can reduce danger and cost. Hence, even more than commercial games, they can be improved and used in the serious games domain for the sake of education.

Considering Kim's virtual landscape classification methodology, we can see that the best serious games have a generating story type, which is highly helpful for the learners to dig into the environment deeper on their own and use their creativity for a better education. In contrast, analyzing the number of assets, it is surprising that the story layer contains the least number of assets. Even considering the background environment of the game, which is an abandoned urbanscape, we can assume that game developers paid more attention to the natural and artificial layers. Additionally, the significant majority of current serious games have a storytelling theme. This means that they may mainly convey their story to the player via the character's dialogues or the texts in the games, which may seem boring for the players to follow. Additionally, this restricts the game to only a target player using specific languages. Hence, we understand that increasing the number of assets in the story layer will assist the players more interactively, with a limited need for long texts and speeches. Regarding the player scale, while it is well-settled in the commercial digital games to play them with *groups* or as *massive* players, it is not yet used in serious games. The contemporary serious game developers could enhance the educational game experience by adding playing and learning features to their games. This will change the serious game domain and add much to it. Figuring out the games regarding their dimension, we could observe that while the player can move both in 2D axis or 3D, the virtual landscape itself in best games of both serious or commercial games are 3D. Considering the growth pattern, the *3D2D* and *3D3D* games are getting more developed compared to the past, however, *2D2D* is the most existing game type due to its convenience in the development process. Hence, it will be for the sake of the serious game industry to focus on developing more 3D virtual environments. Talking about the space shape, despite the rareness of *face* space shape among the database and the most used type in commercial ones, we can see that the five best all have this type of space in their codes. Hence, this leads us to the result that developing more games with face space shapes will enhance the player experience in learning during serious games.

The conducted reverse engineering reveals that the digital game developer and serious game developers do not pay the same amount of attention to all parts of the virtual

landscape. During reverse engineering the games and segregating them to their constituting elements, it is observable that different layers of the landscape have varying numbers of assets. While most of the effort is put into the virtual and natural environments, the media and story layer always have a very limited number of elements. Regarding the interaction level of each game, examining the interactiveness of each asset reveals that serious games have fewer interactive assets than commercial games. Therefore, serious game developers should consider adding more engaging assets to their games to enhance the game's interaction level and improve the learning rate. Considering the situation, it can be concluded that the digital game industry lacks a methodological approach, especially in the area of virtual environment design. Digital game designers, developers, and artists could benefit from Kim's methodologies when it comes to thinking about all aspects of a game's virtual environment and balancing the development process.

5. CONCLUSION AND DISCUSSION

Education has always had a significant role in human beings' lives with natural life occurrences or higher education. With the emergence of the technology era, modern educational methods replaced the traditional ones with the help of ICTs and the Internet. This phenomenon passed the control of time and location from educators to learners. Despite the existence of such a method in people's lives from many years ago, the Covid-19 pandemia made it the only possible way of education. However, along with its positive points, it brought about problems regarding the lack of face-to-face education, which needs an innovative solution.

Serious games increase immersion and motivation, integrate into the educational system, and convey educational content besides entertainment in various domains. The combination of HMDs and the VR experience in this method increases the engagement even more than before and provides riskless and low-budget replicate environments for learning various skills. However, in this process, it is important to be aware of the players' learning rate to control the method's effectiveness. Since the text-based serious games developed during the thesis revealed an inadequacy of interaction and reluctance to follow provided content, the thesis seeks ways of tackling it and increasing the learning rate.

Serious games, as digital games, depending on their virtual landscapes both in the development process and the caring attributes. While the appearance of virtual reality technology increased the importance of the virtual landscape in games, it is challenging to find studies taking them as a design domain, not as a tool for real space enhancement. Although other domains have their own methodologies for their design processes, the gaming industry lacks such a methodology leading to inconsistencies. Therefore, this thesis seeks the relation between virtual landscapes and the evoulution of the serious games. Hence, the research, first of all, developed five serious games and evaluated the learning rate of three games among them. The evaluation results depicted a reluctance regarding following the games and revealed a need for more comprehensive research to find the heal. Hence, then, it investigated the chronological change of the virtual landscapes in serious games during history. It also aims to figure out how this change and the virtual reality technology invention have influenced the

contents transmitted by digital games and its influence on the player interaction and learning rate.

To do so, the researchers used a digital game classification methodology developed by the principles of architecture, landscape architecture, and urban planning to classify the virtual landscapes of the digital games. Hence, we filtered Steam games with education and game tag resulting in 1102 games, ending in 702 games with some eliminations. An Excel database, including various data of the games, sorted chronologically and their gameplays, enabled us to generate the games' classification codes based on their player scale, story, dimension, space shape, and interaction level. The revealed growth patterns gave information about the content educated in the game, the VR technology, and the virtual landscape evolution. Due to the results, we noticed a gradual pattern in their classification codes. We also catch an intimate relationship between virtual landscape evolution and virtual reality emergence with their conveying content. Additionally, they get more 3D, more complicated, and more interactive. Furthermore, we reverse-engineered the five best serious games due to the users' reviews in the database and the five best digital games ever based on IGN 100 best digital games ever, using digital game design methodology to compare with each other. This reverse engineering showed us how the various game assets had been distributed among multiple layers and how they are interactive (Table 5.1).

Table 5.1 : Serious games vs. commercial games reverse engineering comparison.

	Serious Game	Commercial Game
Story Type (Mostly)	Generative	Representative
Player Scale (Mostly)	Single	Groups, Massive
Dimension (Mostly)	3D	3D
Interaction	48%	66%
Head-mounted Display (HMD)	20%	60%

Finally, the thesis proposes a roadmap as a framework for serious game developers to increase player interaction and learning rate. During this process, as mentioned, using a coding system, we reverse engineered ten selected games and gathered data about their assets. However, considering the research's limits, the only choice was to count the assets manually due to the inaccessibility of the raw game data. Additionally, since the number of games for such a conclusion was not enough, more games with a broader range of types should be included for more precise outcomes in the continuation of the study. The other limitation of the study is its approach toward reverse engineering and

the evaluation of the gathered data. As mentioned, the research evaluates the layers based on the number of available assets and has a statistical approach. However, even a single asset may be as powerful as plenty of assets. Hence, having a qualitative attitude could be a possible future study for this database.

The output of this study is not limited to serious games and can be expanded to any virtual landscape for their enhancement. Currently, the landscape architecture field uses the virtual landscape as a tool for enhancing the real world, however, soon, landscape architects will also act in the virtual landscape area as professionals to improve it. Hence, in that time, this study will shed light on the road of the virtual landscape developers for generating interactive environments. Additionally, this data set and the methodologies could be used to develop a tool, as a further study, for the digital game industry to enable the digital game development experts to focus on all layers equally, resulting in more balanced games. Such a tool could reduce the labor, time, and budget needed for game development.

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APPENDICES

APPENDIX A: Raw Database of Serious Games
APPENDIX B: Each Years' Heatmap Database

APPENDIX A

Case number	Game title	Publication Year	Head-mounted Display (HMD)	Simulation	Subject	Story	Player scale	Interaction level	Dimension	Space Shape	Result
1	Scrapping Simulator	2020	No	Yes	Business	G	S	P	33	C	GSP33C
2	Powerboat VR	2020	Yes	Yes	Boat driving	G	G	P	33	C	GGP33C
3	Papa's Quiz	2020	No	No	General information	R	G	N	32	L	RGN32L
4	Wordeous	2020	No	No	General information	G	M	N	22	L	GMN22L
5	Yolo Space Hacker	2020	No	No	Hacking	G	S	N	22	L	GSN22L
6	VR Brewing Simulator	2020	Yes	Yes	Beer brewing	G	S	P	32	S	GSP32S
7	InfiniWordSlide	2020	No	No	Language learning	G	S	N	22	L	GSN22L
8	BOT.vinnik Chess: Opening Traps	2020	No	No	Chess	G	S	N	22	L	GSN22L
9	Mini Moves: Among Stars	2020	No	No	Space	G	S	N	23	L	GSN23L
10	VR Museum	2020	Yes	Yes	History	G	S	N	32	S	GSN32S
11	Zup! Z	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
12	Microjob	2020	Yes	Yes	Language learning	G	G	P	33	S	GGP33S
13	Singularity	2020	Yes	Yes	Art piece VR	G	S	P	32	C	GSP32C
14	Dört Model Müzesi	2020	Yes	Yes	Public relations	R	S	N	33	S	RSN33S
15	Pumping Simulator	2020	No	Yes	Gas station management	G	G	P	32	C	GGP32C
16	Elva the Eco Dragon	2020	No	No	Ecology	R	S	P	33	C	RSP33C
17	Hanoi Puzzles: Solid Match	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
18	The Chess Variants Club	2020	No	No	Chess	G	G	N	32	L	GGN32L
19	Re-Nullum	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
20	Gizmos: Spirit Of The Christmas	2020	No	No	Nonograms	G	S	N	22	L	GSN22L
21	On Key Up: A Game for Keyboards	2020	No	No	Typing	G	S	N	22	L	GSN22L
22	Let's Learn Shogi	2020	No	No	Board game	G	S	N	22	L	GSN22L
23	THE UNIVERSE	2020	Yes	Yes	Astronomy	G	S	P	32	C	GSP32C
24	Qube Qross	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
25	Liminal	2020	Yes	Yes	Psychology	G	S	P	32	C	GSP32C
26	Folkloric Excursion	2020	No	No	Survival	R	S	N	22	L	RSN22L
27	Brandins Buttons	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
28	Frog's Princess	2020	No	No	Kids education	R	S	N	22	L	RSN22L
29	On Closer Inspection	2020	Yes	No	Strategy	G	S	P	32	S	GSP32S
30	Flag Collection	2020	No	No	Flag	G	S	N	22	L	GSN22L
31	Chandrayaan VR	2020	Yes	Yes	Moon Mission	G	S	P	33	C	GSP33C
32	Shredded Secrets	2020	No	No	Kids education	R	S	N	22	L	RSN22L
33	The Conquest of Go	2020	No	No	Classic board	G	G	N	22	L	GGN22L
34	Pixel Puzzles 4k: Japan	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
35	iGuide Knossos VR	2020	Yes	Yes	Architectural Heritage	G	S	N	32	S	GSN32S
36	Proven: A Math RPG	2020	No	No	Math	R	S	N	22	L	RSN22L
37	GENIUS AT WORK!	2020	No	Yes	Building	G	S	N	32	C	GSN32C
38	Girls on puzzle 2	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
39	Das Balkonzimmer	2020	No	Yes	Educational	G	S	P	33	S	GSP33S

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40	Rosy Manga	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
41	Javols VR	2020	No	Yes	History	G	S	N	32	S	GSN32S
42	The Wednesday	2020	No	No	Journey	R	S	N	23	L	RSN23L
43	Shuttle Commander	2020	Yes	Yes	Shuttle	G	S	P	33	S	GSP33S
44	Lynn , The Girl Drawn On Puzzles	2020	No	No	Puzzle	R	S	N	22	S	RSN22S
45	Algebra Ridge	2020	No	No	Algebra	G	S	N	22	L	GSN22L
46	Eye of the Beholder	2020	Yes	Yes	Documentary	R	S	P	33	C	RSP33C
47	Big Cat Rescue VR	2020	Yes	Yes	Animal rescue	G	S	P	32	S	GSP32S
48	Kaverini Nuuk Adventures	2020	No	Yes	Hacking	R	S	N	22	L	RSN22L
49	SUPERCHICOS	2020	No	No	Psychology	R	S	P	33	C	RSP33C
50	Fabulous place	2020	No	No	Card game	R	S	N	22	L	RSN22L
51	Safe Squares	2020	No	No	Board game	G	S	N	22	L	GSN22L
52	Taiwan Richman	2020	No	No	Monopoly	R	G	N	33	L	RGN33L
53	Seasons With Furry	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
54	Charge!	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
55	Linklight	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
56	My Universe - School Teacher	2020	No	No	Teaching	R	S	N	33	S	RSN33S
57	12 Labours of Hercules XI: Painted Adventure	2020	No	No	History	G	S	N	22	L	GSN22L
58	Bunny's Trail	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
59	Mars Horizon	2020	No	Yes	Astronomy	G	S	N	32	S	GSN32S
60	Bee Simulator	2020	No	Yes	Animal	R	S	P	33	C	RSP33C
61	Dorian Morris Adventure	2020	No	No	Life	R	S	N	23	S	RSN23S
62	RGB Simulator	2020	No	Yes	RGB colors	G	S	P	22	S	GSP22S
63	Super Ultimatum Quiz	2020	No	No	General information	G	S	N	22	L	GSN22L
64	ZendoVR	2020	Yes	Yes	Meditation	G	S	N	32	C	GSN32C
65	Vocal Space Shooter	2020	No	No	Psychology	G	S	N	22	L	GSN22L
66	Historical Games: Chariot Racing	2020	Yes	Yes	History	R	S	P	33	C	RSP33C
67	Rover Mechanic Simulator	2020	No	Yes	Mechanic	G	S	N	32	C	GSN32C
68	Professor Rubik's Brain Fitness	2020	No	No	Brain Fitness	G	G	N	22	L	GGN22L
69	Speedily	2020	No	No	Language learning	G	G	N	22	L	GGN22L
70	Flat Earth Simulator	2020	No	No	Astronomy	G	S	N	32	L	GSN32L
71	Cannabis Farmer Strain Master	2020	No	No	Farming	G	S	P	33	C	GSP33C
72	Good puzzle: Castles	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
73	Escape the Lab	2020	Yes	Yes	Escape room	G	S	P	33	C	GSP33C
74	Zniw Adventure	2020	No	No	Kids education	G	S	N	22	L	GSN22L
75	House Flipper VR	2020	Yes	Yes	House flipper	G	S	P	33	C	GSP33C
76	Ostatni Dzien w Pracy	2020	No	No	Logical arcade	R	S	P	22	S	RSP22S
77	Beetle Uprising	2020	No	Yes	Genetic	G	S	P	23	C	GSP23C
78	GridMath	2020	No	No	Math	G	S	N	22	L	GSN22L
79	Coloring Book for Adults	2020	No	No	Coloring book	G	S	N	22	L	GSN22L

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80	BO020880	2020	No	No	Novel	R	S	N	22	L	RSN22L
81	Marble Age: Remastered	2020	No	No	History	R	S	N	22	S	RSN22S
82	Adventures of Megara: Demeter's Cat-astrophe	2020	No	No	Time management	R	S	N	22	S	RSN22S
83	Girls on puzzle	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
84	Fire survival	2020	No	Yes	Survival	R	S	P	33	C	RSP33C
85	Understand	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
86	Nuri VR - Coding	2020	Yes	Yes	Educational	G	S	N	33	S	GSN33S
87	Cube Raiders	2020	No	No	Puzzle	G	G	N	23	S	GGN23S
88	The Tool	2020	No	No	Puzzle	G	S	N	23	C	GSN23C
89	Who Wants To Be A Millionaire	2020	No	No	General information	R	G	N	33	C	RGN33C
90	Sokoban: Bunny Tales	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
91	Fast Typing Master	2020	No	No	Educational	G	S	N	22	L	GSN22L
92	Trivia Tricks	2020	No	No	Trivia	G	G	N	33	C	GGN33C
93	PAGO FOREST: DRAGON'S REVENGE	2020	No	No	Educational	R	S	N	33	C	RSN33C
94	Voyager	2020	No	No	Travel guid	G	S	N	22	L	GSN22L
95	Good puzzle: Music	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
96	Good puzzle	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
97	Physics: Optics Table	2020	Yes	Yes	Physics learning	G	S	P	33	C	GSP33C
98	Noda	2020	Yes	Yes	Mind map	G	S	N	23	C	GSN23C
99	MVorpheus "Content Organizer"	2020	No	No	Board game	G	S	N	22	S	GSN22S
100	TEXT: Russia	2020	No	No	Typing	G	S	N	22	S	GSN22S
101	Scribble It!	2020	No	No	Draw/Guess	G	G	N	22	S	GGN22S
102	Moving Letters	2020	No	No	Language learning	G	S	N	22	L	GSN22L
103	Cyborg Earthworm	2020	No	No	Visual command	G	S	N	22	S	GSN22S
104	Kanaly '44	2020	Yes	Yes	History	G	S	P	33	S	GSP33S
105	Ziggy	2020	No	No	Typing	G	S	N	22	L	GSN22L
106	Vital Signs: Emergency Department	2020	No	No	Medical	G	S	N	22	L	GSN22L
107	Active Neurons - Wonders Of The World	2020	No	No	Brain Fitness	G	S	N	22	S	GSN22S
108	Venture Valley	2020	No	No	Business	G	S	P	22	C	GSP22C
109	Electrify	2020	No	Yes	Brain Fitness	G	G	N	22	S	GGN22S
110	Human Constructor VR	2020	Yes	Yes	Anatomy	G	S	N	33	C	GSN33C
111	The Book of Distance	2020	Yes	Yes	Personal storytelling	G	S	N	22	L	GSN22L
112	Democracy 4	2020	No	Yes	Politics	R	S	N	22	C	RSN22C
113	Let's Learn Japanese! Kanji Sudoku	2020	No	No	Sudoku	G	S	N	22	S	GSN22S
114	BOT.vinnik Chess: Winning Patterns	2020	No	No	Chess	G	S	N	22	S	GSN22S
115	Sheng Tian (升天) - Episode 1	2020	No	No	Language learning	R	S	N	32	C	RSN32C
116	Business Simulator	2020	No	Yes	Business	G	S	N	22	L	GSN22L

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117	Buddi Bot: Machine Learning AI Helper With Advanced Neural Networking!	2020	No	Yes	AI trainer	G	S	P	22	S	GSP22S
118	CAT SUDOKU	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
119	BeetleQuest	2020	No	No	Children book	R	S	N	22	L	RSN22L
120	LA FORET DE PAGO : LA VENGEANCE DU DRAGON	2020	No	No	Language learning	R	S	N	33	C	RSN33C
121	Mondrian - Plastic Reality	2020	No	No	Museum building	G	S	N	22	S	GSN22S
122	SUDOKU TIME	2020	No	No	Sudoku	G	S	N	22	S	GSN22S
123	Chaotic Airport Construction Manager	2020	No	Yes	Airport building	G	S	P	32	C	GSP32C
124	Cubism	2020	Yes	Yes	Brain Fitness	G	S	N	32	S	GSN32S
125	Learn Spanish VR	2020	Yes	Yes	Language learning	G	S	N	32	S	GSN32S
126	DumbBots: Hello World	2020	No	Yes	Code learning	G	S	N	23	C	GSN23C
127	HOLY QURAN VR EXPERİENCE	2020	No	No	Religion	G	S	N	32	C	GSN32C
128	Rover Mechanic Challenge - ERC Competition	2020	No	Yes	Repairing Mars Rovers	G	S	N	32	S	GSN32S
129	心境 VR / Mind VR Exploration	2020	Yes	Yes	Heritage	R	S	P	32	S	RSP32S
130	Episode 1: MissionKT	2020	No	Yes	Extinct creatures	G	S	P	33	C	GSP33C
131	Solar System VR	2020	Yes	Yes	Astronomy	G	S	N	32	C	GSN32C
132	Jung's Labyrinth	2020	No	Yes	Psychology	G	S	P	32	C	GSP32C
133	On Pixels: A lights out game	2020	No	No	Puzzle	G	S	N	22	L	GSN22L
134	Educational Games for Kids	2020	No	No	Kids education	G	S	N	22	C	GSN22C
135	Alias	2020	No	No	Language learning	G	G	N	22	S	GGN22S
136	Where in the World is Carmen Sandiego?	2020	No	No	Geography	R	S	N	22	L	RSN22L
137	Move Code Lines	2020	No	No	Code learning	G	S	N	22	S	GSN22S
138	Tiki Tiki: The Tropical Memory Game	2020	No	No	Memory	G	S	N	22	S	GSN22S
139	Japanese Romaji Adventure	2020	No	No	Language learning	R	S	N	22	S	RSN22S
140	Xtreme Typing	2020	No	No	Typing	G	S	N	22	L	GSN22L
141	Spinodrum	2020	No	Yes	Drum	G	S	N	33	S	GSN33S
142	The Call Centre	2020	No	No	Call center	R	S	N	22	L	RSN22L
143	Mushroom Picker Simulator	2020	No	Yes	phytology	G	S	P	32	C	GSP32C
144	Dental Madness: Cavity Mania	2020	No	Yes	Medical	G	S	N	32	S	GSN32S
145	Critterland	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
146	Dodo Adventures	2020	Yes	Yes	Climate change	R	S	P	32	C	RSP32C
147	Adventures in Morality: An Interactive Case Study	2020	No	No	Sympathy	R	S	P	33	C	RSP33C
148	Frogworld	2020	Yes	Yes	Frog world	G	S	P	32	C	GSP32C
149	Ragnar's Chinese Memory Game	2020	No	No	Language learning	G	S	N	22	S	GSN22S
150	RealFlight Trainer Edition	2020	No	Yes	Flight	G	S	P	33	C	GSP33C

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151	Kebab House	2020	No	No	Restaurant	G	S	N	22	S	GSN22S
152	Korean Adventures in Russia	2020	No	No	Language learning	R	S	N	22	S	RSN22S
153	Watch Your Helmet	2020	No	Yes	Physics learning	G	S	N	22	S	GSN22S
154	Learn Game Development, Unity Code Monkey	2020	No	No	Code learning	R	S	N	22	S	RSN22S
155	This Game Might Improve Your Memory	2020	No	No	Memory	R	S	N	22	S	RSN22S
156	Dinosaur Fossil Hunter: Prologue	2020	No	Yes	Extinct creatures	R	S	P	32	C	RSP32C
157	Brain Test	2020	No	No	Brain Fitness	G	S	N	22	L	GSN22L
158	Kooring VR Coding Adventure	2020	Yes	No	Code learning	R	S	P	33	L	RSP33L
159	Tower! 3D	2020	No	Yes	Airport building	G	S	N	32	C	GSN32C
160	Family Quiz	2020	No	No	General information	G	S	N	32	S	GSN32S
161	Imperiums: Greek Wars	2020	No	No	History	G	M	P	32	C	GMP32C
162	Festoon	2020	Yes	Yes	Software learning	G	S	N	22	S	GSN22S
163	C-TAS: A Virtual Chinese Learning Game	2020	Yes	No	Language learning	G	S	N	22	S	GSN22S
164	FIT Food	2020	No	No	Health	G	G	P	33	C	GGP33C
165	Guess Pictures - Animals	2020	No	No	Animals	G	S	N	22	L	GSN22L
166	Brick Building	2020	No	Yes	City builder	G	S	N	32	S	GSN32S
167	Aenaon	2020	Yes	No	History	R	S	N	32	C	RSN32C
168	LOGistICAL 3: Earth	2020	No	No	Logistic	G	S	N	22	S	GSN22S
169	Galvatia	2020	No	No	Animal rescue	G	S	P	32	C	GSP32C
170	StellaSpella	2020	No	No	Kids education	G	S	N	33	C	GSN33C
171	Quiz Pro - Guess Pictures	2020	No	No	General quiz	G	S	N	22	L	GSN22L
172	Buck Bradley Comic Adventure 2	2020	No	No	Puzzle	R	S	N	22	L	RSN22L
173	Minimal Maze	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
174	illuminati Simulator VR	2020	Yes	Yes	History	G	S	N	32	C	GSN32C
175	Edge of Reality	2020	No	No	Novel	R	S	N	22	L	RSN22L
176	Accident: The Pilot	2020	No	No	Journalist	G	S	P	32	C	GSP32C
177	带摄影师	2020	No	Yes	Photography	G	S	N	32	C	GSN32C
178	完美电路 Electric Circuit	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
179	Two Worlds - The 3D Art Gallery	2020	Yes	Yes	Art piece VR	G	S	N	32	C	GSN32C
180	Being Centered	2020	No	No	Brain Fitness	G	S	N	22	S	GSN22S
181	Gerrymander Madness	2020	Yes	Yes	Politics	G	S	N	32	C	GSN32C
182	The Wake: Mourning Father, Mourning Mother	2020	No	No	Journey	G	S	N	22	L	GSN22L
183	Turn on the light	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
184	Bananas Academy's Psyber	2020	No	No	Computer scinece	G	S	N	22	S	GSN22S
185	The Holy City	2020	Yes	Yes	Religion	G	S	P	32	C	GSP32C
186	Puzzle Dungeon	2020	No	No	Puzzle	G	S	N	22	L	GSN22L
187	Keyboard Piano-ist	2020	No	No	Music	G	S	N	22	S	GSN22S

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188	Plunkocity	2020	No	No	Brain Fitness	G	S	N	22	S	GSN22S
189	World of FUNDO	2020	No	No	History	G	S	N	33	C	GSN33C
190	Britannic: Patroness of the Mediterranean	2020	Yes	Yes	History	G	S	N	32	C	GSN32C
191	BOT.vinnik Chess: Combination Lessons	2020	No	No	Chess	G	S	N	22	S	GSN22S
192	Lighton	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
193	World of Art - learn with Jigsaw Puzzles	2020	No	No	Quiz	G	S	N	22	S	GSN22S
194	Da! Russian Quiz	2020	No	No	Language learning	G	S	N	22	L	GSN22L
195	Barn Finders	2020	No	No	Barn building	G	S	P	32	C	GSP32C
196	Inside the Box	2020	No	No	Logical arcade	G	S	N	22	S	GSN22S
197	Baldi's Basics Plus	2020	No	No	Educational	G	S	N	22	C	GSN22C
198	Beyond Blue	2020	No	Yes	Ocean	G	S	P	33	C	GSP33C
199	HEDE Game Engine	2020	No	No	Game education	G	S	N	22	S	GSN22S
200	PlanetariumVR	2020	Yes	Yes	Planet	G	S	N	32	C	GSN32C
201	COVID: The Outbreak	2020	No	No	Covid	G	S	N	22	S	GSN22S
202	Poly Bridge 2	2020	No	No	Bridge building	G	S	N	22	C	GSN22C
203	Virtual Exhibition	2020	No	Yes	Exhibition	G	S	N	32	C	GSN32C
204	Into The Flames	2020	No	No	Firefighting	G	S	P	32	C	GSP32C
205	Magic Forms	2020	No	No	Puzzle	G	S	N	32	S	GSN32S
206	Rover Mechanic Simulator: Training Day	2020	No	Yes	Mechanic	G	S	N	32	C	GSN32C
207	Journey to the Centre of the Cell	2020	Yes	Yes	Anatomy	G	S	N	32	C	GSN32C
208	3D Math - Ultra	2020	No	No	Math	G	S	N	22	S	GSN22S
209	LIT: Bend the Light	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
210	Buck Bradley: Comic Adventure	2020	No	No	Puzzle	R	S	N	22	L	RSN22L
211	Software Engineering Course / Informatyka - zrozum i zaprogramuj komputer	2020	No	No	Programming	G	S	N	22	S	GSN22S
212	KnotBot	2020	No	No	Programming	R	S	N	22	S	RSN22S
213	Game Of Puzzles: Dinosaurs	2020	No	No	Puzzle	G	S	N	22	L	GSN22L
214	Pair Matching Puzzle Connect	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
215	Cell Defender	2020	No	No	Memory	G	S	N	22	S	GSN22S
216	PiLKO	2020	No	No	Puzzle	G	S	N	22	L	GSN22L
217	PLAYNE : The Meditation Game	2020	Yes	Yes	Meditation	G	S	N	32	C	GSN32C
218	Fill all	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
219	Nimbatus - Drone Creator	2020	No	Yes	Drone	G	S	N	22	S	GSN22S
220	Code Romantic	2020	No	No	Programming	R	S	N	22	S	GSN22S
221	Galactic Protection Squad | Episode 1	2020	Yes	Yes	Space	R	S	P	32	C	RSP32C
222	Let's Learn Korean! Vocabulary	2020	No	No	Language learning	G	S	N	22	S	GSN22S

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223	Memory Player	2020	No	No	Memory	G	S	N	22	S	GSN22S
224	112 Operator	2020	No	No	Operator	G	S	N	32	C	GSN32C
225	Ohayou! Beginner's Japanese	2020	No	No	Language learning	R	S	N	22	S	RSN22S
226	Baby Shark VR Dancing	2020	Yes	No	Kids education	G	S	N	32	C	GSN32C
227	Easy puzzle: Landscape	2020	No	No	Landscape	G	S	N	22	L	GSN22L
228	Building the Universe: The Beginning of Time	2020	No	No	Space	R	S	P	32	C	RSP32C
229	Active Neurons 2	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
230	Receiver 2	2020	No	Yes	Military	G	S	P	32	C	GSP32C
231	Easy puzzle: Bridges	2020	No	No	Puzzle	G	S	N	22	L	GSN22L
232	Virus Popper	2020	Yes	No	Health	G	S	N	32	C	GSN32C
233	PST VR (Primary Surgical Treatment)	2020	Yes	Yes	Surgery	G	S	N	32	C	GSN32C
234	Easy puzzle: Streets	2020	No	No	Puzzle	G	S	N	22	L	GSN22L
235	Virtual Viking	2020	Yes	Yes	Military	G	S	N	32	C	GSN32C
236	Touch Typing Home Row Speed Grinder	2020	No	Yes	Typing	G	S	N	22	S	GSN22S
237	Lucifer: Paradise Lost	2020	No	No	Religion	G	S	N	22	S	GSN22S
238	Pancake Sailor	2020	No	Yes	Sailing	G	S	P	32	C	GSP32C
239	Abacus Finch	2020	No	No	Math	R	S	N	22	L	RSN22L
240	QUIZ PRO! - General Knowledge	2020	No	No	Brain Fitness	G	S	N	22	S	GSN22S
241	Archaid	2020	No	No	Memory	G	S	N	22	S	GSN22S
242	Galactic Center VR	2020	Yes	Yes	Space	G	S	P	32	C	GSP32C
243	Antarctic Heritage Trust	2020	Yes	Yes	Heritage	G	S	P	32	C	GSP32C
244	YATB : You Are The Best - Egypt Chapter	2020	No	No	History	R	S	P	22	S	RSP22S
245	Turniej Robotów	2020	No	No	Programming	R	S	N	22	C	RSN22C
246	Profitania	2020	No	Yes	Business	G	G	N	22	S	GGN22S
247	Kana Quest	2020	No	No	Language learning	G	S	N	22	S	GSN22S
248	Let's Learn Korean! Hangul	2020	No	No	Language learning	G	S	N	22	S	GSN22S
249	Colorful 3D II	2020	No	No	Building	G	S	P	32	S	GSP32S
250	NagiQ	2020	No	No	Language learning	G	S	N	22	S	GSN22S
251	Hiragana POW!	2020	No	No	Language learning	G	S	N	22	S	GSN22S
252	First Contact	2020	No	Yes	Alien space	G	S	N	22	S	GSN22S
253	How do you like it, Elon Musk?	2020	No	Yes	Space	G	S	P	32	F	GSP32F
254	Forest of MATH	2020	No	No	Math	R	S	N	22	S	RSN22S
255	Jungle Town: Birthday quest	2020	No	No	Kids education	R	S	N	22	L	RSN22L
256	Maritime Hegemony : Carrier Travel 海上霸主:航空母 舰之旅	2020	No	Yes	Military	G	S	P	32	C	GSP32C
257	Battle of Brains	2020	No	No	IQ test	G	G	N	22	S	GGN22S
258	Universe Quiz	2020	No	No	Astronomy quiz	G	S	N	22	S	GSN22S
259	S0	2020	No	No	Math	G	S	N	22	C	GSN22C

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260	Car Tuner 2020	2020	No	Yes	Car tuner	G	S	N	32	C	GSN32C
261	Zapitalism	2020	No	No	Strategy	G	S	P	32	C	GSP32C
262	SEN: Seven Eight Nine	2020	No	No	Logical arcade	G	S	N	22	S	GSN22S
263	Arranged	2020	No	No	Traditional	R	S	N	22	L	RSN22L
264	Subway Simulator	2020	No	Yes	Subway	G	S	N	32	C	GSN32C
265	Chinese Brush Simulator	2020	No	Yes	Traditional	G	S	N	32	C	GSN32C
266	Virtual Race Car Engineer 2020	2020	No	No	Race	G	S	N	22	C	GSN22C
267	Game Of Puzzles: Space	2020	No	No	Puzzle	G	S	N	22	S	GSN22S
268	Operation Deep Magic: Cryptanalysis	2020	No	Yes	Programming	G	S	N	22	S	GSN22S
269	A Percent of a Pirate	2020	No	No	Math	R	S	N	23	C	RSN23C
270	Gizmos: Steampunk Nonograms	2020	No	No	Logical	G	S	N	22	S	GSN22S
271	Gazillionaire	2020	No	No	Business	G	S	N	22	S	GSN22S
272	HABITKING RPG	2019	No	No	Brain Fitness	R	S	N	22	S	RSN22S
273	FireTry	2019	No	No	Strategy	R	G	P	22	S	RGP22S
274	Let's Learn Japanese! Vocabulary	2019	No	No	Language learning	G	S	N	22	S	GSN22S
275	Dinodrifters	2019	No	No	Extinct creatures	R	S	N	22	S	RSN22S
276	Titans of Space PLUS	2019	Yes	Yes	Space	G	S	N	32	C	GSN32C
277	Timmy's adventures : VerbMon	2019	No	No	Kids education	R	S	N	22	S	RSN22S
278	Photo Quiz - Animals	2019	No	No	Photo Quiz	G	S	N	22	S	GSN22S
279	Beat.School: DJ Simulator	2019	No	Yes	Music	G	S	N	32	S	GSN32S
280	The Sapling	2019	No	Yes	Life sim	G	S	P	32	F	GSP32F
281	Let's Create! Pottery VR	2019	Yes	Yes	Relaxing	G	S	N	32	S	GSN32S
282	生物知识格斗大赛	2019	No	No	Kids education	R	S	N	22	S	RSN22S
283	Bus Driver Simulator	2019	Yes	Yes	Drive	G	S	P	32	S	GSP32S
284	Biker Garage: Mechanic Simulator	2019	No	Yes	Mechanic	G	S	N	32	C	GSN32C
285	Colorgrid	2019	No	No	Logical	G	S	N	22	S	GSN22S
286	Buzludzha VR	2019	Yes	Yes	Psychology	G	S	P	32	C	GSP32C
287	Npc Problems: Vertex Coloring	2019	No	No	Logical	G	S	N	22	S	GSN22S
288	Battleships and Carriers - Pacific War	2019	No	No	Pacific War	G	S	N	22	S	GSN22S
289	The Endless Mission	2019	No	Yes	Psychology	G	S	P	32	C	GSP32C
290	Voxelgram	2019	No	No	Logical	G	S	N	22	S	GSN22S
291	[MISC] TIMELINES	2019	No	No	History	G	S	N	22	S	GSN22S
292	Brukel	2019	No	Yes	History	R	S	N	32	C	RSN32C
293	Anthropomachy	2019	No	No	History	R	S	N	32	C	RSN32C
294	Solar Cram School/[太阳补习班]	2019	No	No	Educational	G	S	N	22	S	GSN22S
295	Type Knight	2019	No	No	History	R	S	N	22	L	RSN22L
296	Math The Question	2019	No	No	Math	G	S	N	22	S	GSN22S
297	Mini Words - minimalist puzzle	2019	No	No	Puzzle	G	S	N	22	S	GSN22S
298	Language Worm	2019	No	No	Language learning	G	S	N	22	S	GSN22S

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299	War Solution - Casual Math Game	2019	No	No	Math	R	G	N	22	L	RGN22L
300	Active Neurons - Puzzle game	2019	No	No	Puzzle	G	S	N	22	S	GSN22S
301	Morels: The Hunt	2019	No	No	Hunting	G	S	P	32	C	GSP32C
302	Zen Chess: Blindfold Masters	2019	No	No	Chess	G	S	N	22	S	GSN22S
303	Zen Chess: Champion's Moves	2019	No	No	Chess	G	S	N	22	S	GSN22S
304	Wanderlust: Travel Stories	2019	No	No	Travel	R	S	N	32	C	RSN32C
305	For a Better Country	2019	No	No	Country management	G	S	N	22	L	GSN22L
306	Forgetful Dictator	2019	No	No	Strategy	G	S	N	22	S	GSN22S
307	ThreatGEN: Red vs. Blue	2019	No	No	Cyber	R	G	N	22	S	RGN22S
308	Jigsaw Puzzle - Pro Edition	2019	No	No	Puzzle	G	S	N	22	L	GSN22L
309	Learn Spanish! Easy Vocabulary	2019	No	No	Language learning	G	S	N	22	S	GSN22S
310	MarineVerse Cup - Sailboat Racing	2019	Yes	Yes	Sailing	G	G	P	32	C	GGP32C
311	Power Brain Trainer	2019	No	No	Brain Fitness	G	S	N	22	S	GSN22S
312	The Ultra Code	2019	No	No	Programming	G	S	N	22	S	GSN22S
313	Earthlingo	2019	No	No	Language learning	G	S	N	33	C	GSN33C
314	Pictures of Life	2019	No	No	Brain Fitness	G	S	N	32	C	GSN32C
315	WolfQuest: Anniversary Edition	2019	No	Yes	Ecology	G	S	P	33	C	GSP33C
316	Biotope	2019	No	Yes	Aquarium	G	S	N	32	C	GSN32C
317	Robo Instructus	2019	No	No	Programming	R	S	N	22	S	RSN22S
318	EarthX	2019	No	No	Space	G	S	N	32	C	GSN32C
319	Them Bombs	2019	No	No	Board game	G	G	N	22	S	GGN22S
320	Trivia Throwdown	2019	No	No	Strategy	G	G	N	22	S	GGN22S
321	Depixtion	2019	No	No	Puzzle	G	S	N	22	S	GSN22S
322	SpaceEngine	2019	No	Yes	Space	G	S	N	32	C	GSN32C
323	DIY Life	2019	No	Yes	3D Printer	G	S	N	32	C	GSN32C
324	I Know Everything	2019	No	No	Quiz	G	G	N	22	S	GGN22S
325	Fractal Gallery VR	2019	No	Yes	Art piece VR	G	S	N	32	C	GSN32C
326	World of DASM, DASM Spell Quest	2019	No	No	Language learning	R	S	N	32	C	RSN32C
327	Beyond the Stars VR	2019	Yes	Yes	History	G	S	N	32	C	GSN32C
328	Fishing on the Fly	2019	No	Yes	Fishing	G	S	P	32	C	GSP32C
329	Game Of Puzzles: Animals	2019	No	No	Puzzle	G	S	N	22	S	GSN22S
330	Happy Words	2019	No	No	Board game	G	S	N	22	S	GSN22S
331	Koral	2019	No	No	Sea	G	S	N	32	C	GSN32C
332	Smart Gecko	2019	No	No	Puzzle	G	S	N	22	S	GSN22S
333	Diesel Brothers: Truck Building Simulator	2019	No	Yes	Mechanic	G	G	N	32	C	GGN32C
334	Money Makes Money	2019	No	No	Business	G	S	N	22	S	GSN22S
335	Zen Chess: Mate in Four	2019	No	No	Chess	G	S	N	22	S	GSN22S
336	Zen Chess: Mate in Three	2019	No	No	Chess	G	S	N	22	S	GSN22S
337	Zen Chess: Mate in Two	2019	No	No	Chess	G	S	N	22	S	GSN22S

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338	LOGistICAL 2: France	2019	No	No	Strategy	G	S	N	22	S	GSN22S
339	Trash Rage	2019	Yes	Yes	Survival	R	S	N	32	C	RSN32C
340	Maze of Memories	2019	No	No	Maze puzzle	G	S	N	22	S	GSN22S
341	Top Burger	2019	No	No	Restaurant	G	S	N	22	S	GSN22S
342	Gadgeteer	2019	Yes	No	Physics learning	G	S	N	32	C	GSN32C
343	JQ: cosmos	2019	No	No	Quiz	G	S	N	22	S	GSN22S
344	Game Of Puzzles: Nature	2019	No	No	Puzzle	G	S	N	22	S	GSN22S
345	Virtual Arctic Expedition	2019	Yes	Yes	Sea	G	G	P	32	C	GGP32C
346	TribeXR DJ School	2019	Yes	Yes	Music	G	S	N	32	S	GSN32S
347	Hellink	2019	No	No	Investigation	R	S	N	22	S	RSN22S
348	Production Line : Car factory simulation	2019	No	No	Car factory	G	S	N	22	S	GSN22S
349	Sudoku3D 2: The Cube	2019	No	No	Sudoku	G	S	N	22	S	GSN22S
350	Little Mouse's Encyclopedia	2019	No	No	Encyclopedia	G	S	N	22	S	GSN22S
351	LOGistICAL 2: USA - Nevada	2019	No	No	Logistic	G	S	N	22	S	GSN22S
352	Solitaire: Learn Chemistry	2019	No	No	Chemistry	G	S	N	22	S	GSN22S
353	Oik Memory 3	2019	No	No	Memory	G	S	N	22	S	GSN22S
354	Tobit	2019	No	Yes	Relaxing	R	S	N	32	C	RSN32C
355	Evolution Board Game	2019	No	No	Adaptation	R	S	N	22	S	RSN22S
356	Self Reliance 自我性赖	2019	No	No	Life sim	R	S	N	22	L	RSN22L
357	Tales of Ancient Nights	2019	No	No	Tales	R	S	N	22	S	RSN22S
358	PC Building Simulator	2019	No	Yes	PC Building	G	S	N	32	C	GSN32C
359	The Devil's Calculator	2019	No	No	Math	G	S	N	22	S	GSN22S
360	Area Cooperation Economic Simulation: North Korea (ACES)	2019	No	Yes	Economic	G	S	N	22	L	GSN22L
361	Classic Jigsaw Puzzles	2019	No	No	Puzzle	G	S	N	22	S	GSN22S
362	while True: learn()	2019	No	No	Machine Learning	G	S	N	22	C	GSN22C
363	Let's Learn Japanese! Hiragana	2019	No	No	Language learning	G	S	N	22	S	GSN22S
364	Citizen of Rome - Dynasty Ascendant	2019	No	No	Life sim	G	S	N	22	S	GSN22S
365	Timeflow – Time & Money Sim	2019	No	No	Financial	G	S	N	22	S	GSN22S
366	Sudoku3D	2018	No	No	Sudoku	G	S	N	22	S	GSN22S
367	Number Hunt	2018	No	No	Math	G	G	N	32	C	GGN32C
368	ElectricVLab	2018	No	No	Electronics	G	S	N	22	S	GSN22S
369	Wrench	2018	Yes	Yes	Mechanic	G	S	N	32	C	GSN32C
370	Forex Trading Master: Simulator	2018	No	Yes	Business	G	G	N	22	S	GGN22S
371	Solitaire: Learn the Flags!	2018	No	No	Flag	G	S	N	22	S	GSN22S
372	Secrets of the Past: Dion	2018	No	No	Extinct creatures	G	S	N	22	S	GSN22S
373	Project Eagle: A 3D Interactive Mars Base	2018	No	No	Space	G	S	N	32	S	GSN32S
374	Color by Numbers - Animals	2018	No	No	Kids education	G	S	N	22	S	GSN22S

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375	Calcul8²	2018	No	No	Math	G	S	N	22	S	GSN22S
376	Neotrie VR	2018	Yes	No	Geometry	G	S	N	32	C	GSN32C
377	TAL: Jungle	2018	No	No	Maze puzzle	G	S	N	22	S	GSN22S
378	Short Circuit VR	2018	Yes	Yes	Electronics	G	S	N	32	C	GSN32C
379	TOK	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
380	Reentry - An Orbital Simulator	2018	No	Yes	Space	G	S	N	32	C	GSN32C
381	Occupy White Walls	2018	No	No	Art	G	G	N	33	C	GGN33C
382	Color by Numbers - Christmas	2018	No	No	Kids education	G	S	N	22	S	GSN22S
383	Salsa-Virtual	2018	Yes	Yes	Music	G	S	N	33	C	GSN33C
384	Hoyeonjigi	2018	No	No	Kids education	R	S	N	22	L	RSN22L
385	Tombeaux	2018	No	Yes	Virtual environment	G	S	N	32	C	GSN32C
386	Vilmonic	2018	No	No	Building	G	S	N	22	S	GSN22S
387	Project Hospital	2018	No	No	Building	G	S	N	22	S	GSN22S
388	Super X Chess	2018	No	No	Chess	G	S	N	22	S	GSN22S
389	Animals Memory: Horses	2018	No	No	Memory	G	S	N	22	S	GSN22S
390	LOGistICAL 2	2018	No	No	Strategy	G	S	N	22	S	GSN22S
391	Wer weiß denn sowas? - Das Spiel	2018	No	No	TV quiz	G	G	N	33	S	GGN33S
392	Storm of Jigsaw Puzzles 拼图风暴	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
393	Color by Numbers - Halloween	2018	No	No	Painting	G	S	N	22	S	GSN22S
394	God is a Cube: Programming Robot Cubes	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
395	Rogue Bit	2018	No	No	Programming	G	S	N	22	S	GSN22S
396	My Memory of Us	2018	No	No	Tales	R	S	N	22	S	RSN22S
397	OCTOPTICOM	2018	No	No	Programming	G	S	N	22	S	GSN22S
398	Chinese Parents	2018	No	No	Life sim	R	S	N	22	S	RSN22S
399	Species: Artificial Life, Real Evolution	2018	No	Yes	Life sim	G	S	P	32	C	GSP32C
400	Dawn of China: Rise of Qin	2018	No	No	History	R	S	N	22	S	RSN22S
401	Pit Blocks 3D	2018	No	No	Puzzle	G	S	N	32	S	GSN32S
402	Taphouse VR	2018	Yes	No	Bartender	G	S	N	32	C	GSN32C
403	LOGistICAL 2: Belgium	2018	No	No	Strategy	G	S	N	22	S	GSN22S
404	TAL: Arctic 3	2018	No	No	Maze puzzle	G	S	N	22	S	GSN22S
405	Super Seducer 2 - Advanced Seduction Tactics	2018	No	No	Life sim	R	S	N	33	C	RSN33C
406	Obstruction : VR	2018	Yes	No	Puzzle	G	S	N	32	C	GSN32C
407	Liftoff: FPV Drone Racing	2018	No	No	Race	G	G	P	33	C	GGP33C
408	Russpuppy Kid Games	2018	No	No	Kids education	R	S	N	22	S	RSN22S
409	Puppy Chef Academy	2018	Yes	No	Cooking	G	S	N	22	S	GSN22S
410	Puzzles for smart: Dogs	2018	No	No	Kids education	G	S	N	22	S	GSN22S
411	Endless Fighter	2018	No	No	Stress reliever	G	S	N	22	S	GSN22S
412	Panzer Strategy	2018	No	No	Strategy	G	S	N	22	S	GSN22S

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413	Aggressors: Ancient Rome	2018	No	No	History	G	S	N	22	S	GSN22S
414	7 Billion Humans	2018	No	No	Human management	G	S	N	22	S	GSN22S
415	JQ: Beautiful Japan	2018	No	No	Language learning	G	S	N	22	S	GSN22S
416	Der Milchbauer	2018	No	Yes	Farming	G	S	N	22	S	GSN22S
417	Imperialism: Fate of India	2018	No	No	Strategy	G	S	N	22	S	GSN22S
418	Trivia Quiz: All about everything!	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
419	TAL: Arctic 2	2018	No	No	Maze puzzle	G	S	N	22	S	GSN22S
420	Answer The Question	2018	No	No	Math	G	S	N	22	S	GSN22S
421	Learn Japanese To Survive! Kanji Combat	2018	No	No	Language learning	R	S	N	22	L	RSN22L
422	Bang Bang Fruit 3	2018	No	No	Cooking	G	S	N	22	S	GSN22S
423	Beyond Tokyo	2018	Yes	Yes	VR 360 degree	G	S	N	32	C	GSN32C
424	Not Without You	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
425	Wired	2018	No	No	Puzzle	R	S	N	22	S	RSN22S
426	Summer: Jigsaw Puzzles	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
427	Virtual telescope	2018	Yes	Yes	Virtual Telescope	G	S	N	32	S	GSN32S
428	TAL: Arctic	2018	No	No	Maze puzzle	G	S	N	22	S	GSN22S
429	Color by Numbers - Flowers	2018	No	No	Painting	G	S	N	22	S	GSN22S
430	HoloLAB Champions	2018	Yes	Yes	Chemistry	G	S	P	32	C	GSP32C
431	Ice Caves of Europa	2018	No	No	Space	R	S	N	22	S	RSN22S
432	The 50 States Quiz	2018	No	No	Quiz	G	S	N	22	S	GSN22S
433	The King's Request: Physiology and Anatomy Revision Game	2018	No	No	Anatomy	R	S	N	22	S	RSN22S
434	Limouzik	2018	No	No	Music	G	S	N	22	S	GSN22S
435	LOGistICAL: Brazil	2018	No	No	Logistic	G	S	N	22	S	GSN22S
436	Flashing Lights - Police, Firefighting, Emergency Services Simulator	2018	No	Yes	Emergency service	R	S	P	33	C	RSP33C
437	Rookie Math Pro	2018	No	No	Math	R	S	N	33	C	RSN33C
438	Bitcoin Trading Master: Simulator	2018	No	Yes	Business	G	S	N	22	S	GSN22S
439	Cairo's Tale: The Big Egg	2018	Yes	No	Kids education	R	S	N	33	C	RSN33C
440	Math Classroom Challenge	2018	Yes	No	Math	G	S	N	32	C	GSN32C
441	Egypt: Old Kingdom	2018	No	Yes	History	G	S	N	32	S	GSN32S
442	Castle: Jigsaw Puzzles	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
443	Prime Mover	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
444	Common Hanzi Quiz - Simplified Chinese	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
445	LOGistICAL: Caribbean	2018	No	No	Logistic	G	S	N	32	S	GSN32S
446	House Flipper	2018	No	Yes	House renovation	G	S	P	32	C	GSP32C
447	Color by Numbers - Dinosaurs	2018	No	No	Painting	G	S	N	22	S	GSN22S
448	School Fab Lab VR	2018	Yes	Yes	VR Lab	G	S	N	32	C	GSN32C
449	Pestis	2018	No	No	Medical	R	S	N	22	S	RSN22S

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450	Tiny Bubbles	2018	No	No	Physics	G	S	N	22	S	GSN22S
451	Neos VR	2018	Yes	Yes	Metaverse	G	M	P	33	C	GMP33C
452	LOGistICAL: ABC Islands	2018	No	No	Logistic	G	S	N	32	S	GSN32S
453	Jack and Sara: Educational game	2018	No	No	Kids education	R	S	N	22	S	RSN22S
454	HomestarVR	2018	Yes	Yes	Astronomy	G	S	N	32	S	GSN32S
455	Joyo Kanji Quiz	2018	No	No	Kids education	G	S	N	22	S	GSN22S
456	Star Swapper	2018	No	No	Relaxing	G	S	N	22	S	GSN22S
457	Rabbit: Jigsaw Puzzles	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
458	ADR-Labelling Game	2018	No	No	ADR Labelling	G	S	N	22	S	GSN22S
459	Zen Chess: Mate in One	2018	No	No	Chess	G	S	N	22	S	GSN22S
460	Charlotte	2018	No	No	History	R	S	N	32	C	RSN32C
461	JQ: chemistry	2018	No	No	Chemistry	G	S	N	22	S	GSN22S
462	Sudoku Zenkai	2018	No	No	Sudoku	G	G	N	22	S	GGN22S
463	Mother Simulator	2018	No	Yes	Parrent	G	S	N	32	C	GSN32C
464	JQ: dogs & cats	2018	No	No	Quiz	G	S	N	22	S	GSN22S
465	Motorbike Garage Mechanic Simulator	2018	No	No	Mechanic	G	S	N	32	C	GSN32C
466	Bio Inc. Redemption	2018	No	Yes	Medical	G	G	N	22	S	GGN22S
467	Relaxicon	2018	No	No	Language learning	G	S	N	22	S	GSN22S
468	The Geology Game	2018	No	No	Geology	G	S	N	22	S	GSN22S
469	Molecule - a chemical challenge	2018	No	No	Chemistry	G	S	N	22	S	GSN22S
470	OVERVIEW (A Walk Through The Universe)	2018	Yes	Yes	Space	R	S	N	32	S	RSN32S
471	Musician	2018	No	No	Music	G	S	N	22	S	GSN22S
472	Discovery Tour by Assassin's Creed®: Ancient Egypt	2018	No	Yes	History	R	S	P	33	F	RSP33F
473	Cypher	2018	No	No	Cryptography	G	S	N	32	C	GSN32C
474	Animals Memory: Cats	2018	No	No	Memory	G	S	N	22	S	GSN22S
475	JQ: countries	2018	No	No	Flag quiz	G	S	N	22	S	GSN22S
476	SOK MAX	2018	No	No	Puzzle	G	S	N	22	S	GSN22S
477	Math Hero	2018	No	No	Math	G	S	N	22	S	GSN22S
478	LOGistICAL: Russia	2018	No	No	Logistic	G	S	N	32	S	GSN32S
479	Martha Madison: Forces	2018	No	No	Kids education	R	G	N	22	S	RGN22S
480	Comrades and Barons: Solitaire of Bloody 1919	2018	No	No	Educational Card game	G	S	N	22	S	GSN22S
481	Eco	2018	No	No	Ecology	R	G	P	33	C	RGP33C
482	Puzzle for Kids	2018	No	No	Kids education	G	S	N	22	S	GSN22S
483	Kirchhoff's Revenge	2018	No	Yes	Electrical circuits	R	S	N	32	C	RSN32C
484	Dr. Umgebung's School of Life	2018	No	Yes	Kids education	R	S	P	22	S	RSP22S
485	Doodle God: Alchemy Jam	2018	No	No	Science learning	G	S	N	22	S	GSN22S
486	Animals Memory: Insect	2018	No	No	Memory	G	S	N	22	S	GSN22S

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487	Animals Memory: Underwater Kingdom	2018	No	No	Memory	G	S	N	22	S	GSN22S
488	Animals Memory: Dogs	2018	No	No	Memory	G	S	N	22	S	GSN22S
489	Animals Memory: Birds	2018	No	No	Memory	G	S	N	22	S	GSN22S
490	Math RTS	2018	No	No	Math	G	G	N	22	S	GGN22S
491	JuVentures	2018	No	No	Hidden object game	G	S	N	22	S	GSN22S
492	Oh No! Ninjas!	2018	No	No	Typing	G	S	N	22	S	GSN22S
493	LOGistICAL: South Africa	2018	No	No	Logistic	G	S	N	32	S	GSN32S
494	ChemCaper™: Act I - Petticles in Peril	2017	No	No	Chemistry	R	S	N	33	C	RSN33C
495	Oik Memory	2017	No	No	Memory	G	S	N	22	S	GSN22S
496	Reading Simulator	2017	No	Yes	Library simulator	G	S	N	32	C	GSN32C
497	Bridge Constructor Portal	2017	No	Yes	Strategy	G	S	N	22	S	GSN22S
498	MuX	2017	Yes	Yes	Music	G	S	N	32	S	GSN32S
499	Puzzle Chambers	2017	No	No	Puzzle adventure	R	S	N	22	S	RSN22S
500	It's Quiz Time	2017	No	No	Quiz	G	G	N	22	S	GGN22S
501	Znkl - 177	2017	No	No	Puzzle	G	S	N	22	S	GSN22S
502	Aerofly FS 2 Flight Simulator	2017	Yes	Yes	Flight Simulator	G	S	P	33	F	GSP33F
503	Sudokube	2017	No	No	Sudoku-Relaxation	G	S	N	22	S	GSN22S
504	LOGistICAL: Switzerland	2017	No	No	Logistic	G	S	N	32	S	GSN32S
505	Paradiddle	2017	Yes	Yes	Music VR	G	S	N	22	S	GSN22S
506	The Ultimate Trivia Challenge	2017	No	No	Quiz	G	S	N	22	S	GSN22S
507	Bang Bang Fruit 2	2017	No	No	Cooking	G	S	N	22	S	GSN22S
508	LOGistICAL: USA - New York	2017	No	No	Logistic	G	S	N	32	S	GSN32S
509	Trivia Vault: Video Game Trivia Deluxe	2017	No	No	Quiz	G	S	N	22	S	GSN22S
510	Engare	2017	No	No	Geometric Architecture	G	S	N	22	S	GSN22S
511	Relik	2017	No	No	Puzzle	G	G	N	22	S	GGN22S
512	Math Fun	2017	No	No	Math	G	S	N	22	S	GSN22S
513	Stonehenge VR SANDBOX	2017	Yes	Yes	Voyager VR	G	S	P	32	C	GSP32C
514	LOGistICAL: Japan	2017	No	No	Logistic	G	S	N	32	S	GSN32S
515	CAT Interstellar	2017	No	Yes	Astronomy	R	S	P	33	C	RSP33C
516	Arms Race - TCWE	2017	No	No	History	G	S	N	22	S	GSN22S
517	I was here	2017	No	No	Landmark Quiz	G	S	N	22	S	GSN22S
518	CompliKATed	2017	No	No	Binary puzzle	G	S	N	22	S	GSN22S
519	LOGistICAL: Chile	2017	No	No	Logistic	G	S	N	32	S	GSN32S
520	LOGistICAL: Norway	2017	No	No	Logistic	G	S	N	32	S	GSN32S
521	LOGistICAL: USA - Oregon	2017	No	No	Logistic	G	S	N	32	S	GSN32S
522	Double Memory	2017	No	No	Memory	R	S	N	22	S	RSN22S
523	Silicon Zeroes	2017	No	Yes	Hardware simulator	G	S	N	22	S	GSN22S

Case number	Game title	Publication Year	Head-mounted Display (HMD)	Simulation	Subject	Story	Player scale	Interaction level	Dimension	Space Shape	Result
524	Jigsaw Puzzles	2017	No	No	Kids education	G	S	N	22	S	GSN22S
525	Code World	2017	No	No	Coding	G	S	N	22	S	GSN22S
526	Archaica: The Path of Light	2017	No	No	History	G	S	N	32	S	GSN32S
527	Madu Maths	2017	No	No	Kids education	G	S	N	22	S	GSN22S
528	LOGistICAL: USA - Florida	2017	No	No	Logistic	G	S	N	32	S	GSN32S
529	BOOKS	2017	No	No	Animal world	G	S	N	32	S	GSN22S
530	LOGistICAL: Italy	2017	No	No	Logistic	G	S	N	32	S	GSN32S
531	Legends Of Iona RPG (2007 arcade)	2017	No	No	Strategy	R	S	P	33	C	RSP33C
532	VR Battleship YAMATO	2017	Yes	Yes	World War II	R	S	P	33	C	RSP33C
533	The Museum of ThroughView	2017	Yes	Yes	VR Museum	G	S	N	32	C	GSN32C
534	LOGistICAL: British Isles	2017	No	No	Logistic	G	S	N	32	S	GSN32S
535	Breaking Good	2017	No	No	Chemistry	G	S	N	22	S	RSN22S
536	Puzzle: Underwater World	2017	No	No	Classical puzzle	G	S	N	22	S	GSN22S
537	Car Mechanic Simulator 2018	2017	No	Yes	Mechanic	G	S	N	32	S	GSN32S
538	Micro Cosmic Worlds	2017	Yes	Yes	Microcosmos	G	S	N	32	C	GSN32C
539	Dry Erase: Infinite VR Whiteboard	2017	Yes	No	Whiteboard	G	S	N	32	S	GSN32S
540	Nurbits	2017	No	Yes	Sound engineer	G	S	N	32	S	GSN32S
541	Against the Gradient	2017	No	No	Microscopic world	G	S	N	22	S	GSN22S
542	Solarium	2017	No	Yes	Plants	G	S	P	32	C	GSP32C
543	Flagsplosion	2017	No	No	Flag quiz	G	S	N	22	S	GSN22S
544	Mocove Arts VR	2017	Yes	No	Virtual museum	G	S	N	32	C	GSN32C
545	Pixel Painter	2017	No	No	Painting	G	S	N	22	S	GSN22S
546	Planetary Settlers	2017	No	Yes	Space	G	S	N	32	C	GSN32C
547	Hidden Animals: English - Spanish	2017	No	No	Hidden object game	G	S	N	22	S	GSN22S
548	4D Toys	2017	No	No	Kids education	G	S	N	22	S	GSN22S
549	Lamp Head	2017	No	No	Exploration	R	S	N	22	S	RSN22S
550	BeanVR—The Social VR APP	2017	Yes	No	Metaverse	G	S	P	33	C	GSP33C
551	Intelligent Design: An Evolutionary Sandbox	2017	No	No	Genetics	G	S	N	32	C	GSN32C
552	Block'hood	2017	No	Yes	City building	G	S	N	32	S	GSN32S
553	PsychLabVR	2017	Yes	Yes	Psychologic lab	G	S	N	32	C	GSN32C
554	Odyssey - The Story of Science	2017	No	No	General Science	G	S	N	32	C	GSN32C
555	X-Plane 11	2017	Yes	Yes	Flight Simulator	G	S	P	33	C	GSP33C
556	Train Mechanic Simulator 2017	2017	No	Yes	Mechanic	G	S	N	32	C	GSN32C
557	Algotica Iterations	2017	No	No	Programming	G	S	N	32	S	GSN32S
558	LyraVR	2017	Yes	Yes	Music	G	S	N	32	S	GSN32S
559	Quizality	2017	Yes	No	VR Quiz	G	G	N	22	S	GGN22S
560	911 Operator	2017	No	No	Emergency service	G	S	N	22	S	GSN22S
561	FEMINAZI: The Triggering	2017	No	No	Psychological	G	S	N	22	S	GSN22S
562	InMind 2 VR	2017	Yes	No	Scientific journey	R	S	N	32	S	RSN32S
563	LOGistICAL	2017	No	No	Logistic	G	S	N	32	S	GSN32S

Case number	Game title	Publication Year	Head-mounted Display (HMD)	Simulation	Subject	Story	Player scale	Interaction level	Dimension	Space Shape	Result
564	Bang Bang Fruit	2017	No	No	Cooking	G	S	N	22	S	GSN22S
565	Take On Mars	2017	No	No	Space	G	S	N	32	C	GSN32C
566	DvDrum, Ultimate Drum Simulator!	2017	No	Yes	Music	G	S	N	22	S	GSN22S
567	LogicBots	2017	No	No	Logic puzzle	G	S	N	32	C	GSN32C
568	Mondly: Learn Languages in VR	2017	Yes	Yes	Language learning	G	S	N	32	C	GSN32C
569	Learn Japanese To Survive! Katakana War	2017	No	No	Language learning	R	S	N	22	S	RSN22S
570	Home Tech VR	2017	Yes	No	Home production	G	S	N	32	C	GSN32C
571	Pictopix	2017	No	No	Math puzzle	G	S	N	22	S	GSN22S
572	MHRD	2017	No	No	Hardware design	G	S	N	22	S	GSN22S
573	FISH LAKE	2016	No	No	Culture	R	S	P	33	C	RSP33C
574	Satellite Command	2016	No	Yes	Astrophysics simulator	G	S	N	32	S	GSN32S
575	Glittermitten Grove	2016	No	No	City building	R	S	N	22	S	RSN22S
576	Tyto Online	2016	No	No	Space	R	M	P	33	C	RMP33C
577	SHENZHEN I/O	2016	No	No	Programming	G	S	N	22	S	GSN22S
578	City Car Driving	2016	Yes	Yes	Driving simulator	G	S	N	32	C	GSN32C
579	Political Animals	2016	No	No	Election campaign simulation	R	S	N	22	S	RSN22S
580	Predynastic Egypt	2016	No	No	History	R	S	N	22	S	RSN22S
581	Rocksmith® 2014 Edition - Remastered	2016	No	Yes	Music	G	S	N	22	S	GSN22S
582	The Body VR: Journey Inside a Cell	2016	Yes	Yes	Human body	G	S	N	32	S	GSN32S
583	Rescue Bear Operation	2016	No	No	Wildfire awareness	G	S	P	33	C	GSP33C
584	Hardware Engineering	2016	No	No	Hardware design	G	S	N	22	S	GSN22S
585	God of Word	2016	No	No	Language learning	R	S	N	22	S	RSN22S
586	Security Hole	2016	No	No	Hacking	R	S	N	22	S	RSN22S
587	Niche - a genetics survival game	2016	No	Yes	Genetic testing	G	S	P	33	C	GSP33C
588	PRINCIPIA: Master of Science	2016	No	Yes	Science learning	G	S	N	22	S	GSN22S
589	Pure Chess Grandmaster Edition	2016	No	No	Chess	G	S	N	32	S	GSN32S
590	The Cold War Era	2016	No	No	Strategy	G	S	N	22	S	GSN22S
591	Bloxiq VR	2016	Yes	No	Logic puzzle	G	S	N	32	S	GSN32S
592	Toon Ocean VR	2016	Yes	No	Kids education	G	S	P	32	C	GSP32C
593	The VR Museum of Fine Art	2016	Yes	Yes	Virtual museum	G	S	N	32	C	GSN32C
594	Super Markup Man	2016	No	No	Programming	G	G	N	22	S	GGN22S
595	Cyber Sentinel	2016	No	No	Hacking	R	S	N	22	S	RSN22S
596	Bad Rats Show	2016	No	No	Physics	R	S	N	33	C	RSN33C
597	Poly Bridge	2016	No	No	Physics	G	S	N	33	S	GSN33S
598	Flute Master	2016	No	No	Music	G	S	N	22	S	GSN22S
599	Doodle Kingdom	2016	No	No	Brain teaser	R	S	N	22	S	RSN22S
600	ARTé: Mecenas®	2016	No	No	History	R	S	N	22	S	RSN22S

Case number	Game title	Publication Year	Head-mounted Display (HMD)	Simulation	Subject	Story	Player scale	Interaction level	Dimension	Space Shape	Result
601	ABC Coloring Town	2016	No	No	Language learning	G	S	N	22	S	GSN22S
602	Time Machine VR	2016	Yes	No	Time machine VR	R	S	N	32	C	RSN32C
603	Typefighters (Steam Edition)	2016	No	No	Typing	G	S	N	22	S	GSN22S
604	Tyto Ecology	2016	No	No	Ecology	G	S	N	32	C	GSN32C
605	Discovering Colors - Animals	2016	No	No	Painting	G	S	N	22	S	GSN22S
606	Automata Empire	2016	No	No	Strategy	G	S	N	22	S	GSN22S
607	Game Tycoon 2	2016	No	No	Industry	G	S	N	32	S	GSN32S
608	Odd||Even	2016	No	No	Math	G	S	N	22	S	GSN22S
609	Fantastic Contraption	2016	Yes	No	Building	G	S	N	32	C	GSN32C
610	Carpe Lucem - Seize The Light VR	2016	Yes	No	Strategy	G	S	N	32	S	GSN32S
611	GEO Master	2016	No	No	Geography	G	G	N	32	S	GGN32S
612	Epistory - Typing Chronicles	2016	No	No	Origami puzzle	R	S	N	32	C	RSN32C
613	Steno Arcade	2016	No	No	Music	G	S	N	22	S	GSN22S
614	Hydra Slayer	2016	No	No	Math	G	S	N	22	S	GSN22S
615	Hiragana Pixel Party	2016	No	No	Language learning	R	S	N	22	S	RSN22S
616	ChaosTower	2016	No	No	Physics	G	S	N	22	S	GSN22S
617	Zeus vs Monsters - Math Game for kids	2016	No	No	Kids education	G	S	N	22	S	GSN22S
618	String Theory	2016	No	No	Music	G	S	N	22	S	GSN22S
619	Learn Japanese To Survive! Hiragana Battle	2016	No	No	Language learning	R	S	N	22	S	RSN22S
620	It's Spring Again	2016	No	No	Kids education	R	S	N	22	S	RSN22S
621	Water Bears VR	2016	Yes	Yes	Water	G	S	N	32	S	GSN32S
622	Stop Online - Battle of Words	2016	No	No	Language learning	G	G	N	22	S	GGN22S
623	iFactor	2016	No	No	Math	G	G	N	22	S	GGN22S
624	WolfQuest: Classic	2015	No	No	Wildfire awareness	R	S	P	33	C	RSP33C
625	Zoombinis	2015	No	No	Logic puzzle	R	S	N	22	S	RSN22S
626	Human Resource Machine	2015	No	No	Programming	G	S	N	22	S	GSN22S
627	Professor Why™ Chemistry 1	2015	No	No	Chemistry	G	S	N	32	S	GSN32S
628	Last Days of Spring Visual Novel	2015	No	No	Novel	G	S	N	22	S	GSN22S
629	Amos From Outer Space	2015	No	No	Kids education	R	S	N	22	S	RSN22S
630	Kanji Training Game	2015	No	No	Language learning	G	S	N	22	S	GSN22S
631	Mondrian - Abstraction in Beauty	2015	No	No	Relaxing	G	S	N	22	S	GSN22S
632	CodeSpells	2015	No	No	Programming	G	G	P	33	C	GGP33C
633	InCell VR	2015	Yes	No	Human body	R	S	N	32	C	RSN32C
634	Universe Sandbox	2015	Yes	Yes	Space	G	S	N	32	S	GSN32S
635	Egyptian Senet	2015	No	No	History	R	G	N	22	S	RGN22S
636	Big Thinkers 1st Grade	2015	No	No	Kids education	G	S	N	22	S	GSN22S
637	Hacknet	2015	No	No	Hacking	G	S	N	22	S	GSN22S
638	President for a Day - Floodings	2015	No	No	Strategy	G	S	N	22	S	GSN22S
639	President for a Day - Corruption	2015	No	No	Strategy	G	S	N	22	S	GSN22S

Case number	Game title	Publication Year	Head-mounted Display (HMD)	Simulation	Subject	Story	Player scale	Interaction level	Dimension	Space Shape	Result
640	TIS-100	2015	No	No	Programming	G	S	N	22	S	GSN22S
641	The Language Game	2015	No	No	Language learning	G	S	N	22	S	GSN22S
642	Playing History: Vikings	2015	No	No	History	R	S	N	33	C	RSN33C
643	RESCUE 2: Everyday Heroes	2015	No	No	Firefighter	G	S	N	33	C	GSN33C
644	Metamorphabet	2015	No	No	Language learning	G	S	N	22	S	GSN22S
645	Kerbal Space Program	2015	No	No	Space	G	S	P	33	F	GSP33F
646	Car Mechanic Simulator 2015	2015	No	No	Mechanic	G	S	N	33	S	GSN33S
647	Defend Your Life: TD	2015	No	No	Human body	R	S	N	22	S	RSN22S
648	Automation - The Car Company Tycoon Game	2015	No	No	Mechanic	G	S	N	33	S	GSN33S
649	Pixel: ru²	2015	No	No	Puzzle	G	S	N	22	S	GSN22S
650	Tokyo School Life	2015	No	No	Dating sim	R	S	N	22	S	RSN22S
651	The Electric Shocktopus	2015	No	No	Kids education	R	S	N	22	S	RSN22S
652	InMind VR	2015	Yes	No	Science learning	G	S	N	32	C	GSN32C
653	HyperRogue	2015	No	No	Puzzle	G	S	N	22	S	GSN22S
654	Synonymy	2014	No	No	Language learning	G	G	N	22	S	GGN22S
655	A Golden Wake	2014	No	No	Real state	R	S	N	22	C	RSN22C
656	Khet 2.0	2014	No	No	Strategy	G	G	N	23	S	GGN23S
657	The Counting Kingdom	2014	No	No	Math	G	S	N	22	S	GSN22S
658	Crazy Plant Shop	2014	No	No	Plants	R	S	N	22	S	RSN22S
659	Sokobond	2014	No	No	Chemistry	G	S	N	22	S	GSN22S
660	Ludwig	2014	No	No	Physics	R	S	N	33	C	RSN33C
661	GearCity	2014	No	Yes	Business	G	S	N	32	S	GSN32S
662	World of Guns: Gun Disassembly	2014	No	No	Gun learning	G	S	N	32	S	GSN32S
663	Influent	2014	No	No	Language learning	G	S	N	32	C	GSN32C
664	Squirt's Adventure	2014	No	No	Language learning	R	S	N	22	S	RSN22S
665	Car Mechanic Simulator 2014	2014	No	No	Mechanic	G	S	N	32	S	GSN32S
666	Songs2See	2013	No	No	Music	G	S	N	22	S	GSN22S
667	Type:Rider	2013	No	No	History	R	S	N	22	S	RSN22S
668	The Typing of The Dead: Overkill	2013	No	No	Typing	R	S	N	32	S	RSN32S
669	Democracy 3	2013	No	No	Politics	G	S	N	22	S	GSN22S
670	Playing History 2 - Slave Trade	2013	No	No	History	R	S	N	32	S	RSN32S
671	Bronze Age - HD Edition	2013	No	No	History	R	S	N	22	S	RSN22S
672	Total War™: ROME II - Emperor Edition	2013	No	No	History	G	M	N	32	S	GMN32S
673	Europa Universalis IV	2013	No	No	History	G	G	N	32	S	GGN32S
674	Reach for the Sun	2013	No	No	Plants	G	S	N	22	S	GSN22S
675	Scribblenauts Unlimited	2013	No	No	Logic puzzle	R	S	N	22	F	RSN22F
676	An Occurrence at Owl Creek Bridge	2013	No	No	History	R	S	N	22	L	RSN22L
677	Curious Alice	2012	Yes	No	Tales	R	S	N	32	C	RSN32C
678	Disney Winnie the Pooh	2011	No	No	Kids education	R	S	N	22	C	RSN22C

Case number	Game title	Publication Year	Head-mounted Display (HMD)	Simulation	Subject	Story	Player scale	Interaction level	Dimension	Space Shape	Result
679	SpaceChem	2011	No	No	Chemistry	G	S	N	22	S	GSN22S
680	Fate of the World	2011	No	No	Strategy	G	S	N	22	S	GSN22S
681	Air Forte	2010	No	No	General Science	G	G	N	22	C	GGN22C
682	Hacker Evolution	2010	No	Yes	Hacking	G	S	N	22	S	GSN22S
683	Mission Biotech	2010	No	No	Biotechnology	G	S	N	32	C	GSN32C
684	Osmos	2009	No	No	Physics	G	S	N	22	S	GSN22S
685	Margot's Word Brain	2008	No	No	Language learning	G	S	N	22	S	GSN22S
686	Fantastic Contraption Classic 1 & 2	2008	No	No	Physics learning	G	S	N	22	S	GSN22S
687	Die drei Freunde von der Reitschule	2007	No	No	Kids education	R	S	N	33	C	RSN33C
688	Civilization IV: Beyond the Sword	2007	No	No	Strategy	G	S	N	32	S	GSN32S
689	Typer Shark! Deluxe	2006	No	No	Typing	G	S	N	22	S	GSN22S
690	Super 3-D Noah's Ark	2005	No	No	History	R	S	N	33	C	RSN33C
691	Casino Blackjack	2004	No	No	Card game learning	G	S	N	22	S	GSN22S
692	Casino Poker	2004	No	No	Card game learning	G	S	N	22	S	GSN22S
693	Freddi Fish 3: The Case of the Stolen Conch Shell	1998	No	No	Kids education	R	S	N	22	S	RSN22S
694	Freddi Fish and Luther's Water Worries	1996	No	No	Kids education	R	S	N	22	S	RSN22S
695	Freddi Fish 2: The Case of the Haunted Schoolhouse	1996	No	No	Kids education	R	S	N	22	S	RSN22S
696	Let's Explore the Airport (Junior Field Trips)	1995	No	No	Airport	G	S	N	22	S	GSN22S
697	Let's Explore the Farm (Junior Field Trips)	1995	No	No	Farming	G	S	N	22	S	GSN22S
698	Let's Explore the Jungle (Junior Field Trips)	1995	No	No	Explore jungle	G	S	N	22	S	GSN22S
699	Freddi Fish and the Case of the Missing Kelp Seeds	1994	No	No	Kids education	R	S	N	22	S	RSN22S
700	Putt-Putt® and Fatty Bear's Activity Pack	1994	No	No	Kids education	R	S	N	22	S	RSN22S
701	Math Rescue	1992	No	No	Kids education	R	S	N	22	S	RSN22S
702	Word Rescue	1992	No	No	Kids education	R	S	N	22	S	RSN22S

APPENDIX B

Year	Number of educational games	Dimension											
		2D2D			2D3D			3D2D			3D3D		
		Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Total Num	Percentage
1992	2	2	2	100.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
1994	2	2	4	100.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
1995	3	3	7	100.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
1996	2	2	9	100.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
1998	1	1	10	100.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
2004	2	2	12	100.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%
2005	1	0	12	0.00%	0	0	0.00%	0	0	0.00%	1	1	100.00%
2006	1	1	13	100.00%	0	0	0.00%	0	0	0.00%	0	1	0.00%
2007	2	0	13	0.00%	0	0	0.00%	1	1	50.00%	1	2	50.00%
2008	2	2	15	100.00%	0	0	0.00%	0	1	0.00%	0	2	0.00%
2009	1	1	16	100.00%	0	0	0.00%	0	1	0.00%	0	2	0.00%
2010	3	2	18	66.66%	0	0	0.00%	1	2	33.33%	0	2	0.00%
2011	3	3	21	100.00%	0	0	0.00%	0	2	0.00%	0	2	0.00%
2012	1	0	21	0.00%	0	0	0.00%	1	3	100.00%	0	2	0.00%
2013	11	7	28	63.63%	0	0	0.00%	4	7	36.36%	0	2	0.00%
2014	12	6	34	50.00%	1	1	8.33%	4	11	33.33%	1	3	8.33%
2015	30	19	53	70.37%	0	1	0.00%	4	15	14.81%	4	7	14.81%
2016	51	30	83	58.82%	0	1	0.00%	15	30	29.41%	6	13	11.76%
2017	79	37	120	46.83%	0	1	0.00%	35	65	44.30%	7	20	8.86%
2018	128	88	208	68.75%	0	1	0.00%	29	94	22.65%	11	31	8.59%
2019	94	62	270	65.95%	0	1	0.00%	30	124	31.91%	2	33	2.12%
2020	271	157	480	57.93%	9	10	3.32%	70	194	25.83%	35	68	12.91%

Year	Number of educational games	Head-mounted Display (HMD)						Simulation			
		Yes			No			Yes		No	
		Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Percentage	Number	Percentage
1992	2	0	0	0.00%	2	2	100.00%	0	0.00%	2	100.00%
1994	2	0	0	0.00%	2	4	100.00%	0	0.00%	2	100.00%
1995	3	0	0	0.00%	3	7	100.00%	0	0.00%	3	100.00%
1996	2	0	0	0.00%	2	9	100.00%	0	0.00%	2	100.00%
1998	1	0	0	0.00%	1	10	100.00%	0	0.00%	1	100.00%
2004	2	0	0	0.00%	2	12	100.00%	0	0.00%	2	100.00%
2005	1	0	0	0.00%	1	13	100.00%	0	0.00%	1	100.00%
2006	1	0	0	0.00%	1	14	100.00%	0	0.00%	1	0.00%
2007	2	0	0	0.00%	2	16	100.00%	0	0.00%	2	100.00%
2008	2	0	0	0.00%	2	18	100.00%	0	0.00%	2	100.00%
2009	1	0	0	0.00%	1	19	100.00%	0	0.00%	1	100.00%
2010	3	0	0	0.00%	3	22	100.00%	1	33.33%	2	66.66%
2011	3	0	0	0.00%	3	25	100.00%	0	0.00%	3	100.00%
2012	1	1	1	100.00%	0	25	0.00%	0	0.00%	1	100.00%
2013	11	0	1	0.00%	100	125	100.00%	0	0.00%	100	100.00%
2014	12	0	1	0.00%	21	146	100.00%	1	8.30%	11	91.70%
2015	30	3	4	10.00%	27	173	90.00%	1	3.30%	29	96.70%
2016	51	9	13	17.60%	42	215	82.40%	8	15.70%	43	84.30%
2017	79	17	30	21.50%	62	277	78.50%	22	27.80%	57	72.20%
2018	128	16	46	12.50%	112	389	87.50%	24	18.80%	104	81.30%
2019	94	10	56	10.60%	84	473	89.40%	24	25.50%	70	74.50%
2020	271	49	105	18.10%	222	695	81.90%	88	32.50%	183	67.50%

Year	Number of educational games	Interaction level								
		None			Partial			All		
		Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Total Num	Percentage
1992	2	2	2	100.00%	0	0	0.00%	0	0	0.00%
1994	2	2	4	100.00%	0	0	0.00%	0	0	0.00%
1995	3	3	7	100.00%	0	0	0.00%	0	0	0.00%
1996	2	2	9	100.00%	0	0	0.00%	0	0	0.00%
1998	1	1	10	100.00%	0	0	0.00%	0	0	0.00%
2004	2	2	12	0.00%	0	0	0.00%	0	0	0.00%
2005	1	1	13	100.00%	0	0	0.00%	0	0	0.00%
2006	1	1	14	100.00%	0	0	0.00%	0	0	0.00%
2007	2	2	16	100.00%	0	0	0.00%	0	0	0.00%
2008	2	2	18	100.00%	0	0	0.00%	0	0	0.00%
2009	1	1	19	100.00%	0	0	0.00%	0	0	0.00%
2010	3	3	22	100.00%	0	0	0.00%	0	0	0.00%
2011	3	3	25	100.00%	0	0	0.00%	0	0	0.00%
2012	1	1	26	100.00%	0	0	0.00%	0	0	0.00%
2013	11	11	37	100.00%	0	0	0.00%	0	0	0.00%
2014	12	12	49	100.00%	0	0	0.00%	0	0	0.00%
2015	30	27	76	90.00%	3	3	10.00%	0	0	0.00%
2016	51	46	122	90.20%	5	8	9.80%	0	0	0.00%
2017	79	71	193	89.90%	8	16	10.10%	0	0	0.00%
2018	128	119	312	93.00%	9	25	7.00%	0	0	0.00%
2019	94	84	396	89.40%	10	35	10.60%	0	0	0.00%
2020	271	212	608	78.20%	59	94	21.80%	0	0	0.00%

Year	Number of educational games	Results (Top 3)								
		1st			2nd			3rd		
		Code	Number	Percentage	Code	Number	Percentage	Code	Number	Percentage
1992	2	RSN22S	2	100.00%	-	0	0.00%	-	0	0.00%
1994	2	RSN22S	2	100.00%	-	0	0.00%	-	0	0.00%
1995	3	GSN22S	3	100.00%	-	0	0.00%	-	0	0.00%
1996	2	RSN22S	2	100.00%	-	0	0.00%	-	0	0.00%
1998	1	RSN22S	1	100.00%	-	0	0.00%	-	0	0.00%
2004	2	GSN22S	2	100.00%	-	0	0.00%	-	0	0.00%
2005	1	RSN33C	1	100.00%	-	0	0.00%	-	0	0.00%
2006	1	GSN22S	1	100.00%	-	0	0.00%	-	0	0.00%
2007	2	GSN32S	1	50.00%	RSN33C	1	50.00%	-	0	0.00%
2008	2	GSN22S	2	100.00%	-	0	0.00%	-	0	0.00%
2009	1	GSN22S	1	100.00%	-	0	0.00%	-	0	0.00%
2010	3	GSN22C	2	66.66%	GSN22S	1	33.33%	-	0	0.00%
2011	3	GSN22S	2	66.66%	RSN22C	1	33.33%	-	0	0.00%
2012	1	RSN32C	1	100.00%	-	0	0.00%	-	0	0.00%
2013	11	GSN22S	3	27.30%	RSN32S	2	18.20%	RSN22S	2	18.20%
2014	12	GSN32S	3	25.00%	RSN22S	2	16.70%	GSN22S	2	16.70%
2015	30	GSN22S	13	43.30%	RSN22S	5	16.70%	GSN33S	2	6.70%
2016	51	GSN22S	16	31.40%	RSN22S	11	21.60%	GSN32S	7	13.70%
2017	79	GSN22S	30	16.50%	GSN32S	18	22.80%	GSN32C	13	16.50%
2018	128	GSN22S	71	55.50%	GSN32C	13	10.20%	RSN22S	9	7.00%
2019	94	GSN22S	42	44.70%	GSN32C	12	12.80%	RSN22S	8	8.50%
2020	271	GSN22S	75	27.70%	GGN22L	35	12.90%	GSN32C	24	8.90%

Year	Number of educational games	Space Shape											
		Linear			Spot			Chain			Face		
		Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Total Num	Percentage
1992	2	0	0	0.00%	2	2	100.00%	0	0	0.00%	0	0	0.00%
1994	2	2	2	100.00%	0	2	0.00%	0	0	0.00%	0	0	0.00%
1995	3	0	2	0.00%	3	5	100.00%	0	0	0.00%	0	0	0.00%
1996	2	0	2	0.00%	2	7	100.00%	0	0	0.00%	0	0	0.00%
1998	1	0	2	0.00%	1	8	100.00%	0	0	0.00%	0	0	0.00%
2004	2	0	2	0.00%	2	10	100.00%	0	0	0.00%	0	0	0.00%
2005	1	0	2	0.00%	0	10	0.00%	1	1	100.00%	0	0	0.00%
2006	1	0	2	0.00%	1	11	100.00%	0	1	0.00%	0	0	0.00%
2007	2	0	2	0.00%	1	12	50.00%	1	2	50.00%	0	0	0.00%
2008	2	0	2	0.00%	2	14	100.00%	0	2	0.00%	0	0	0.00%
2009	1	0	2	0.00%	1	15	100.00%	0	2	0.00%	0	0	0.00%
2010	3	0	2	0.00%	1	16	33.33%	2	4	66.66%	0	0	0.00%
2011	3	0	2	0.00%	2	18	66.70%	1	5	33.30%	0	0	0.00%
2012	1	0	2	0.00%	0	18	0.00%	1	6	100.00%	0	0	0.00%
2013	11	1	3	9.10%	9	27	81.80%	0	6	0.00%	1	1	9.10%
2014	12	0	3	0.00%	9	36	75.00%	3	9	25.00%	0	1	0.00%
2015	30	0	3	0.00%	23	59	76.70%	6	15	20.00%	1	2	3.30%
2016	51	0	3	0.00%	39	98	76.50%	12	27	23.50%	0	2	0.00%
2017	79	0	3	0.00%	57	155	72.20%	21	48	26.60%	1	3	1.30%
2018	128	2	5	1.60%	97	252	75.80%	28	76	21.90%	1	4	0.80%
2019	94	6	11	6.40%	59	311	62.80%	28	104	29.80%	0	4	0.00%
2020	271	62	73	22.90%	120	431	44.30%	88	192	32.50%	0	4	0.00%

Year	Number of educational games	Story						Player scale								
		Generating			Representing			Single			Group			Massive		
		Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Total Num	Percentage	Number	Total Num	Percentage
1992	2	0	0	0.00%	2	2	100.00%	2	2	100.00%	0	0	0.00%	0	0	0.00%
1994	2	0	0	0.00%	2	4	100.00%	2	4	100.00%	0	0	0.00%	0	0	0.00%
1995	3	3	3	100.00%	0	4	0.00%	3	7	100.00%	0	0	0.00%	0	0	0.00%
1996	2	0	3	0.00%	1	5	0.00%	2	9	100.00%	0	0	0.00%	0	0	0.00%
1998	1	0	3	0.00%	1	6	100.00%	1	10	100.00%	0	0	0.00%	0	0	0.00%
2004	2	2	5	100.00%	0	6	0.00%	2	12	100.00%	0	0	0.00%	0	0	0.00%
2005	1	0	5	0.00%	1	7	100.00%	1	13	100.00%	0	0	0.00%	0	0	0.00%
2006	1	1	6	100.00%	0	7	0.00%	1	14	100.00%	0	0	0.00%	0	0	0.00%
2007	2	1	7	50.00%	1	8	50.00%	1	15	100.00%	0	0	0.00%	0	0	0.00%
2008	2	2	9	100.00%	0	8	0.00%	2	17	0.00%	0	0	0.00%	0	0	0.00%
2009	1	1	10	100.00%	0	8	0.00%	1	18	100.00%	0	0	0.00%	0	0	0.00%
2010	3	3	13	100.00%	0	8	0.00%	2	20	66.66%	1	1	33.33%	0	0	0.00%
2011	3	2	15	66.70%	1	9	33.30%	3	23	100.00%	0	1	0.00%	0	0	0.00%
2012	1	0	15	0.00%	1	10	100.00%	1	24	100.00%	0	1	0.00%	0	0	0.00%
2013	11	5	20	45.50%	6	16	54.50%	9	33	81.80%	1	2	9.10%	1	1	9.10%
2014	12	8	28	66.70%	4	20	33.30%	10	43	83.30%	2	4	16.70%	0	1	0.00%
2015	30	21	49	70.00%	9	29	30.00%	28	71	93.30%	2	6	6.70%	0	1	0.00%
2016	51	35	84	68.60%	16	45	31.40%	46	117	90.20%	4	10	7.80%	1	2	2.00%
2017	79	70	154	88.60%	9	54	11.40%	76	193	96.20%	3	13	3.80%	0	2	0.00%
2018	128	106	260	82.80%	22	76	17.20%	117	310	91.40%	10	23	7.80%	1	3	0.80%
2019	94	75	335	79.80%	19	95	20.20%	85	395	90.40%	9	32	9.60%	0	3	0.00%
2020	271	215	550	79.30%	56	151	20.70%	251	646	92.60%	18	50	6.60%	2	5	0.70%

Year	Number of educational games	Subjects (Top 3)								
		1st			2nd			3rd		
		Name	Number	Percentage	Name	Number	Percentage	Name	Number	Percentage
1992	2	Kids education	1	50.00%	Math	1	50.00%	-	0	0.00%
1994	2	Kids education	2	100.00%	-	0	0.00%	-	0	0.00%
1995	3	Airport	1	33.33%	Farming	1	33.33%	Explore jungle	1	33.33%
1996	2	Kids education	2	100.00%	-	0	0.00%	-	0	0.00%
1998	1	Kids education	1	100.00%	-	0	0.00%	-	0	0.00%
2004	2	Card game learning	2	100.00%	-	0	0.00%	-	0	0.00%
2005	1	History	1	100.00%	-	0	0.00%	-	0	0.00%
2006	1	Typing	1	100.00%	-	0	0.00%	-	0	0.00%
2007	2	Kids education	1	50.00%	Strategic	1	50.00%	-	0	0.00%
2008	2	Language learning	1	50.00%	Physics learning	1	50.00%	-	0	0.00%
2009	1	Physics	1	100.00%	-	0	0.00%	-	0	0.00%
2010	3	General Science	1	33.33%	Hacking	1	33.33%	Biotechnology	1	33.33%
2011	3	Kids education	1	33.33%	Programming	1	33.33%	Strategic	1	33.33%
2012	1	Tales	1	100.00%	-	0	0.00%	-	0	0.00%
2013	11	History	6	54.50%	Logic puzzle	1	9.10%	Plants	1	9.10%
2014	12	Language learning	3	25.00%	Physics	1	8.30%	Business	1	8.30%
2015	30	Language learning	3	10.00%	Kids education	3	10.00%	Programming	3	10.00%
2016	51	Language learning	4	7.80%	Music	4	7.80%	Math	3	5.90%
2017	79	Logistic	10	12.70%	Kids education	3	3.80%	Quiz	3	3.80%
2018	128	Puzzle	14	10.90%	Kids education	11	8.60%	Math	7	5.50%
2019	94	Puzzle	8	8.50%	Language learning	6	6.40%	Chess	5	5.30%
2020	271	Puzzle	41	15.10%	Language learning	2	0.70%	History	2	0.70%

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EDUCATION :

- **B.Sc.** **:** 2016, Azad University, Engineering Faculty, Architectural Engineering Department

PROFESSIONAL EXPERIENCE AND REWARDS:

- 2022 DigitalFUTURES Summer Workshops 2022, bo[AR]d GAME: Tools and Methods for Architectural Heritage Augmentation, 5 days in the English language / Workshop Instructor
- 2022 Gamification of Design Heritage: Participation as a Research Method, Massachusetts Institute of Technology, Department of Architecture, USA / Guest Speaker
- 2021-2022 Researcher at Virtual Landscape Lab, Department of Architecture, Istanbul Technical University
- 2021 Best Presentation Award at ASCAAD 2021 Conference, Cairo, Egypt.
- 2021 Ivan Petrovic Prize (Best presentation by a young researcher) at 39th eCAADe Conference, Novi Sad, Serbia.
- 2021 TÜBİTAK 1512 Entrepreneurship Support Program (Grant) - The Online Platform Design Tool for the Digital Game Industry / Co-founder.
- 2021 ITU Entrepreneurship Incubation, Istanbul Technical University, Turkey.
- 2021- Digital Caravanserai Project - conducted by Associate Prof. Dr. Varinlioğlu, sponsored by the Fulbright Visiting Scholar Program, and hosted by Prof. Nagakura at MIT, Department of Architecture, supported by AKMED for its field studies.
- 2021 Gamification and Twine Platform Workshop, Master course, İzmir University of Economics, Turkey / Workshop Instructor
- 2019 1st Prize at Architect and Entrepreneur Startup Weekend, Urmia, Iran

PUBLICATIONS ON THE THESIS:

- **Vaez Afshar, S., Eshaghi, S. & Kim, I.** 2022. Pattern Analysis of Virtual Landscape within Educational Games. *Journal of Digital Landscape Architecture: HYBRID: Analog + Digital = The next normal, DLA 2022*, 435-442.

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- **Eshaghi, S., Vaez Afshar, S., and Varinlioğlu, G.** 2021. THE SERICUM VIA: A Serious Game for Preserving Tangible and Intangible Heritage of Iran. *9th International Conference of the Arab Society for Computer Aided Architectural Design: Architecture in the Age of Disruptive Technologies, ASCAAD 2021*, 306-316.
- **Vaez Afshar, S., Aytaç, G., and Eshaghi, S.** 2021. SU: A Serious Game for Water Management - Based on Istanbul. *XXV International Conference of the Ibero-American Society of Digital Graphics: Designing Possibilities-Ubiquitous Conference, SIGraDi 2021*, 523-532.
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- **Vaez Afshar, S., Eshaghi, S., Varinlioğlu, G., and Balan, Ö.** 2021. Evaluation of Learning Rate in Serious Game: Based on Anatolian Cultural Heritage. *39th International Conference of Education and Research in Computer Aided Architectural Design in Europe: Towards a new, configurable architecture, eCAADe 2021*, 273-280.
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- **Aytaç, G., Aluçlu, G., Dalay, L. & Vaez Afshar, S.** 2022. Around Water: A Research-Based Landscape Design Studio. *Journal of Design Studio, Landscape Research*, 35-50.