

# Gamification in Space Exploration

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## ABSTRACT

Gamification is a technique that incorporates game-like elements into non-game contexts to make learning more engaging. It is used to engage the public, especially students, in space missions. It can be used to train astronauts and educate the public about space. Gamification elements, such as competition, rewards, and interactive challenges, can be used to encourage exploration. Space exploration in games can be mind-numbing or jaw-dropping, depending on one's expectations. The aim of this paper is to describe how the gamification approach has been applied within the space sector.

**KEYWORDS:** *games, gamification, space gamification, space exploration, space colonization*

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## INTRODUCTION

Games are widely popular and entertaining. The games industry is one of the most lucrative industries due to the billion dollar sales of digital games. The global game marketplace includes video game console hardware and software and online, mobile, and PC games. Games are designed systematically, thoughtfully, and artistically for the purpose of creating fun and enjoyment. Figure 1 shows various uses of games. The difference between regular and “serious” games is that the latter promote “serious” purposes, such as learning and motivation.

Although games and gamification have a lot in common, they are not exactly the same. Gamification, as opposed to serious gaming, is the process of applying the science and psychology of digital gaming (such as video game elements) in a non-game environment. It is the craft of deriving all the fun in games and applying them to productive activities [1].

Gamification is a strategy that uses game-like elements to make learning more engaging and interactive. Gamification in space exploration represents a relatively recent but innovative approach

to astronaut training and public engagement. It has been used in space education to help students learn about space and develop skills for careers in the space sector.

## WHAT IS GAMIFICATION?

The word “gamification” was coined in 2002 by Nick Pelling, a British inventor, but it did not gain popularity until 2010. The idea of gamification came from the fact that the gaming industry was the first to master human-focused design and we are now learning from games. Gamification is not a new concept, but it is deeply rooted in marketing endeavors, such as points cards, grades, and degrees, and workplace productivity [2]. Researchers became interested in gamification because the concept could be implemented in different ways to motivate people. Gamification has become hugely popular in all walks of life, including education. The concept of gamification is illustrated in Figure 2 [3].

The gamification can be viewed in two ways: (1) adopting the act of playing a video game into everyday use, (2) the act of using game elements to

make non-games more enjoyable. It is applied in education, business, sports, marketing, and finance. It is currently one of the largest trends in education. Traditional education has been found to be ineffective in motivating and engaging many students. Gamification is cutting-edge approach which is producing positive results in every region of the world.

Everyone loves games. Gamification just takes advantage of that innate desire. It can make practice fun. It can make the routine less dull. Online games have become bolder and more diverse. Gamification involves the introduction of gameplay to a traditionally non-game environment. Its goal is to encourage user engagement. There are several organizations that use gamification to engage users. These include US Army, Nile, Hilton Garden, McDonald, and Starbucks. The impact of gamification on employees is demonstrated in Figure 3 [4].

### GAMIFICATION IN SPACE EXPLORATION

The cosmos has long been an irresistible frontier, beckoning humanity to explore its vast mysteries. Space is the final frontier, and it's not an easy or cheap to explore. It is full of mystery, as typically shown in Figure 4 [5]. We, as humans, are driven to try to solve all the mysteries that we can. But we must prepare and train astronauts before we can embark on the interstellar odyssey. The preparation for space travel is not only demanding but also deeply complex, involving a myriad of skills. This is where gamification comes in. Gamification has recently emerged as a creative and powerful tool for engaging learners and improving the effectiveness of education. It is a concept that involves applying game-like elements, such as competition, rewards, and interactive challenges, to non-game contexts to engage and motivate individuals. Some space companies are taking the lead, harnessing the power of gamification to transform astronaut training, Figure 5 shows one of the most popular space exploration games, known as No Man's Sky [6].

Some examples of gamification in space exploration include [7]:

- *Space Simulations*: The use of space simulations, which replicate the conditions and challenges of space travel, predates formal gamification efforts. Early astronaut training programs often incorporated simulation-based training exercises.
- *Apollo Exploration Missions*: A serious game that simulates lunar roving activities, such as planning routes, loading equipment, and driving the rover. The game uses 3D terrains and spacecraft models to create a realistic environment.

- *NASA Space Voyagers*: A game where players take turns using spacecraft and instruments to explore a destination. Players tally research points, roll dice to get challenges, and take actions based on the destination card. Figure 6 illustrates the Voyager game [8].
- *MapUncover*: A mobile map app that uses gamification to encourage users to explore. The app has a leaderboard that limits the number of visible users to 100, and the top three users receive a trophy.

### APPLICATIONS OF GAMIFICATION IN SPACE EXPLORATION

Game is a fundamental human practice that can spark curiosity and facilitate skills acquisition and behavioral change. Gamification (or gameful design) is a popular motivation enhancement method. It is regarded as the use of game elements and game-design techniques in non-game contexts. It operates in space exploration in the following ways [7,9]:

- *Astronaut Training*: One area that has seen significant interest in gamification is the training of the astronauts. Space agencies and training centers develop realistic simulations of space missions, including microgravity environments and extravehicular activities. These simulations often include game-like challenges, such as repairing equipment or conducting experiments. Gamified training systems track astronauts' progress, awarding points or achievements for completing tasks or demonstrating proficiency in specific skills. This tracking helps astronauts monitor their development and identify areas for improvement. Astronauts may participate in friendly competitions, either individually or as part of a team. Competition fosters a sense of achievement and encourages continuous improvement.
- *Space Education*: Gamification, a modern learning approach, has garnered attention for its potential to spark space science education. The gamification approach empowers educators to build stronger collaboration and interaction among students and teachers. Integrating gamification into the educational landscape can revolutionize traditional learning paradigms. Space education's gamification can help inspire students to learn about space and build the knowledge, vision, and skills. Space agencies and educational institutions create space-themed games and apps for the public. These games teach astronomy, physics, and space science engagingly and entertainingly. Space agencies run online challenges and competitions that allow the public

to tackle real-world space problems. Participants may be asked to propose solutions to specific challenges, with rewards or recognition for successful ideas. Gamification can also be used to make learning more interactive and engaging by breaking learning down into smaller, achievable tasks. Common gamification elements include points, timers, badges, and leaderboards. Figure 7 shows aeronautic practice-space for engaging students in learning activities [10].

- *Problem-Solving:* Private space companies and organizations often host innovation challenges with substantial cash prizes. These challenges encourage participants to develop innovative solutions to complex problems in space exploration, employing gamification to motivate inventors. Gamification can be used to crowdsource ideas and solutions for space-related issues. Challenges and competitions provide incentives for participants to contribute their expertise and creativity. Figure 8 shows the workflow of the space exploration learning experience [9].
- *Virtual Reality Training:* While not traditionally gamification, virtual reality is used to create immersive, game-like training simulations. Astronauts can practice critical tasks in a realistic but controlled environment, enhancing their readiness for space missions. Advanced simulations, perhaps incorporating virtual reality (VR) and augmented reality (AR), will provide immersive and highly realistic training experiences.

## BENEFITS

Gaming is not just for kids, so to speak. Using gamification in and of itself is training students for how they may conduct tasks in their professional careers. Gamification whether it uses space as its arena or not, can be a valuable guidance tool for educators looking to implement gamification in their teaching. Gamification approach is used within the space sector to develop online and offline resources to foster passion and interest in STEM (Science, Technology, Engineering and Mathematics)-related subjects. Gamification can help with the mental and physical well-being of astronauts in space. Astronauts can experience loneliness and boredom in microgravity environments, so games and recreational activities can help with enjoyment and relaxation. Other benefits of space gamification include the following [7]:

- *Advanced Training:* Gamification will play an even more critical role in astronaut training.

Advanced simulations, perhaps incorporating virtual reality (VR) and augmented reality (AR), will provide immersive and highly realistic training experiences. These simulations will enable astronauts to practice complex tasks and emergencies, enhancing their preparedness for space missions.

- *Public Education:* Gamification will continue to be a powerful tool for engaging the public in space exploration. More interactive educational games and citizen science projects will emerge, allowing individuals to actively contribute to scientific research and deepen their understanding of space. One of the main benefits of gamification in space education is that it can help to motivate learners by using an exciting and thought-provoking endeavor. This can help to motivate students to invest more time and effort into learning about space. Another benefit of gamification in space education is that it can help to make learning more interactive.
- *Remote Space Missions:* As space agencies plan for more extended missions to distant destinations like Mars, gamification will become essential for maintaining crew morale, mental health, and engagement during extended periods of isolation and confinement. Gamified activities and challenges can help combat boredom and stress.
- *Virtual Space Tourism:* As commercial space tourism grows, gamification will be integrated into the passenger experience. Passengers may engage in simulated missions or space-themed games during their journeys to make the experience more exciting and informative.
- *International Collaboration:* Gamification can serve as a bridge for international collaboration in space exploration. Jointly developed gamified projects and competitions can foster cooperation among space agencies and organizations worldwide.
- *Lunar Exploration:* Games can be combine with information about the Moon, scientific principles, realism, and intelligent applications of technology to offer an engaging interaction and play. It challenges users to accomplish a lunar exploration mission, which imitates what astronauts did with the Apollo Lunar Roving Vehicle (LRV). The gameplay mechanics is developed based on the actual activities performed by the astronauts on the lunar surface. Visualization of the Earth, Moon, or solar system has been used in many space themed games.

## CHALLENGES

The transformative potential of gamification in space education is not without its challenges. Space is a unique environment! It is so scary on its own because it is so big, so dark, and so filled with unknown things that we cannot even start to comprehend. As humanity ventures further into space, leveraging the unique conditions of microgravity becomes increasingly imperative. Other challenges of space gamification include the following [11]:

- *Digital Divide*: This denotes a division between people who have access and use digital media (e.g., the Internet, mobile, PC, etc.) and those who do not. Typically, this gap is more prominent in developing nations where the socioeconomic living conditions are worse. The digital divide which may become a limit in designing online gamification activities in developing nations.
- *Risk*: Without the extensive knowledge in space travel, it may be difficult for a civilian to be fully informed of the risks of a trip to space, even with the FAA's required Q&A session. Gamification risks to over-emphasize rewards may inadvertently erode intrinsic motivation.
- *Regulation*: Regulation of preparation is also an issue when sending a civilian to space, especially if that preparation is part of a televised competition. From an international law perspective, the outdatedness of widely adopted treaties regarding outer space results in the complete exclusion of any provisions mentioning the relatively new concept of civilian space travel or space tourism.
- *Complexity*: Player engagement is a multifaceted construct that goes beyond mere participation, encompassing emotional, cognitive, and behavioral dimensions. Designing gamification elements that resonate with a diverse learner profile is a significant challenge. A one-size-fits-all approach may lead to disengagement among learners who do not find the gamified elements motivating. The successful adoption and advancement of gamification in educational settings hinge significantly on the perspectives of its primary end-users.
- *Gamification in Schools*: Teaching space science in schools can be challenging, while on the other hand, students feel a special attraction towards hands-on activities.

## SPACE GAMIFICATION AROUND THE WORLD

Gamification is approaching maturity in the education and enterprise retail sectors. It is being adopted across

many industries, including education, healthcare, marketing, and employee training. It will continue to grow in popularity across a variety of industries. We will also continue to see gamification's impact in the space sector. Africa shall see the fastest growth rate, with gamification in the region forecasted to expand by 60.1% by 2023. We consider how gamification is applied in the space exploration of the following nations [4,12]:

- *United States*: National Aeronautics and Space Administration (NASA) is an independent agency of the US federal government responsible for the civilian space program, as well as aeronautics and space research. NASA has used video games to train astronauts to handle medical issues in space. Large enterprises are expected to hold the largest market share in gamification. Companies such as Oracle, Hewlett Packard, IBM, and Google will help drive this trend.
- *Europe*: In Europe, the European Space Agency (ESA) project helps to foster interest and passion for STEM-related studies and to stimulate young people's awareness of Europe's space program. The ESA Education Office has launched the ESA Kids (2021) website. ESA Kids targets primary school kids from ages 3 to 10 years old. This e-learning platform offers many didactic resources presented through a gamified setup. Such projects demonstrate how gamification can make space education more engaging and interactive and inspire learners to explore the world of space. In Europe, the support of local governments and key stakeholders will help to bolster this growth. For example, policymakers in the United Kingdom and France will host more gamification conferences and events.
- *China*: China has made great strides in exploring space in recent years, rocketing astronauts to its own space station and bringing back rocks from the moon. Now it wants to turn those feats into scientific advances. Museums, which are among the most popular science institutions outside schools, usually display and introduce historical culture and cultural relics to tourists
- *India*: As India is now reaching Moon, Mars, and beyond, with that it is extremely important for the young minds of the 21st Century to learn about space science and its possible applications. The Indian Space Research Organization (ISRO) aims at enhancing space education and awareness among students and the general public.

## CONCLUSION

Space exploration carried out by astronauts has inspired younger generations to study science and

engineering. Everyone loves to know about the rockets and space travel. To rekindle the youth interest in STEM and prepare them for the growth of STEM occupations, serious games have been made by science museums and space centers. The integration of gamification techniques into various sectors, such as exploration sector, has been a notable trend. Gamification will play a critical role in astronaut training and public education. It has become a popular form to promote learning engagement. The future of gamification in space exploration holds significant promise, as it continues to evolve and expand its influence in various aspects of the field. More information on the integration of gamification into space exploration is available from the books in [13,14] and the following related journals:

- *Space Policy*
- *Journal on Emerging Technologies*

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Figure 1 Different uses of games.



Figure 2 The concept of gamification [3].

The Impact of Gamification



Figure 3 The impact of gamification on employees [4].



**Figure 4 Space is full of mystery [5].**



**Figure 5 A popular space exploration game, known as No Man's Sky [6].**



**Figure 6 NASA Voyager game [9].**



Figure 7 Aeronautic practice-space for engaging students [10].

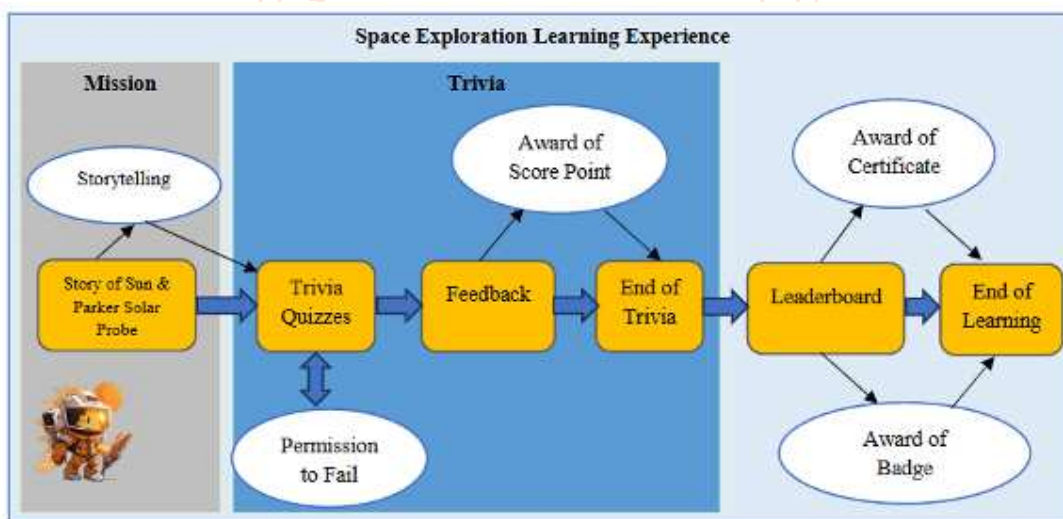


Figure 8 Workflow of the space exploration learning experience [9].