Gamification of Educational Virtual Worlds in the Metaverse

Dimitrios Magetos[1], Sarandis Mitropoulos[2]

[1]*IT Teacher, PhD(c), Department of Informatics/ University of Piraeus, Greece*
[2]*School of Science & Technology/ Hellenic Open University, Greece*

Abstract: The rapid advancement of digital technologies has transformed the landscape of education, with the metaverse emerging as a new and immersive learning platform. At the same time, gamification has proven to be a powerful pedagogical strategy for enhancing student engagement and motivation. The convergence of these two fields - educational virtual worlds and game-based learning - opens new avenues for experiential and interactive education. This study explores the integration of gamification into educational virtual environments in the metaverse, focusing on how game design elements, such as points, badges, levels, and collaborative missions, can be incorporated to support pedagogical goals. Building on the existing literature, this research proposes a methodology for designing immersive, game-enriched educational experiences. The study examines both the benefits and limitations of such applications, highlighting the potential of collaborative design as a means to enhance creativity, motivation, and deeper engagement.
Keywords: Education, Gamification, Metaverse, Minecraft, Virtual Worlds, Roblox

1. Introduction

The rapid development of digital technologies has created new possibilities for the educational process. The metaverse, as a collective virtual world that combines augmented and virtual reality, presents a revolutionary platform for learning. At the same time, gamification has proven to be an effective tool for enhancing the learning experience.

This amalgamation of the two directions: technological and pedagogical, leads to new horizons of education. Educational metaverse virtual worlds can include gamification, and would generate an immersion, interaction, and educational performance setting.

Educational gamification, specifically in the context of virtual worlds in metaverse, is the application of elements of game design to educational settings and is aimed at improving student engagement, motivation and learning outcomes. It has become one of the most popular innovative approaches of the recent years when educators strive to ensure adaptation to the changes in technological models and help to address various needs therein. Through games like points, badges, and interactive activities, gamification turns ordinary learning experiences into active exercises that should lead to full involvement in active learning, and a better grasping of the content [1][2].

The advent of the virtual worlds and the metaverse has also increased the possibility of the immersive learning environments. These systems allow students to have collaborative experiences and to model real-world experiences and thus, should encourage critical thinking and problem solving. As an example, it is possible to engage busy students with digital reproductions of historical locations or with online field trips, which makes inaccessible material more accessible and familiar [3][4]. Studies have shown that this type of immersive form of education has received a huge improvement in terms of knowledge retention and higher levels of engagement, with participation rates increasing by 60 percent in some instances as opposed to conventional methods [5][6].

Despite its advantages, the implementation of gamification in educational settings is not without challenges. Concerns surrounding data privacy, accessibility, and the risk of fostering unhealthy competition among students have emerged. Additionally, the reliance on advanced technology may create disparities in access to quality educational experiences, further exacerbating existing inequalities in education [7][8]. As educational institutions navigate these challenges, ongoing research and thoughtful integration of gamification strategies are essential to harness its full potential in shaping future learning environments.

The paper discusses how the notion of gamification can be applied in education virtual worlds in the metaverse, outlining the main advantages and issues. Although current literature usually focuses on the theory or assesses the implemented applications, little attention is given to design practices as perceived by the educator.

This study contributes to the literature by presenting a documented methodology for designing educational virtual worlds with gamification elements in the metaverse. It emphasizes both pedagogical and technological components that support immersive, collaborative, and creative learning. As a model of good practice, it details the design process and the selection of gamified features that foster active student participation. Its added value lies in offering a practical framework that can be adopted by educators,

researchers, and instructional designers seeking to implement gamification in virtual environments with low technical demands and high educational impact.

The structure of this paper is as follows: section II refers to the theoretical background, section III to the methodology of the study, section IV to the results, section V to the discussion and section VI to the conclusions of this study.

2. Theoretical Background and Literature Review

2.1 Gamification in education

The theoretical framework of gamification in education, particularly within virtual worlds and the metaverse, is heavily influenced by constructivist learning theory. This perspective posits that knowledge is actively constructed through dialogue, inquiry, and hands-on exploration [7][9].

The history of gamification in education can be traced back several decades, although it gained significant prominence in the last ten years as a response to evolving educational needs and technological advancements. Initially employed in corporate training settings, the concept began to shift toward academic environments, where educators sought innovative ways to enhance student engagement and learning outcomes [1][2].

Those mechanisms used in games have become applied to the learning process known as gamification, which enables a more interactive and fun way of learning. Educators have found it worth to eliminate the traditional classroom practice by utilizing game elements like points, badges, and leaderboard to keep students motivated and attract them towards learning [3][4]. As a result of this change, the gamification of education has achieved a different level due to the development of the corresponding tools that enhance the educational content and fill the gap between theoretical knowledge and its practical application [1][5].

The possibility of immersive learning environments emerged with the emergence of virtual worlds. Using virtual environments, students learn collaboratively, using avatars, and learn on virtual field trips with access to experiences that might otherwise be inaccessible because of financial or physical barriers [4]. The most notable applications of the technology are those that pertain to high-precision modeling digital replica of historical sites where students can explore and comprehend important cultural contexts without the need to physically travel[6].

With the ongoing implementation of digital technologies in educational institutions, the gamification coupled with virtual worlds has become one of the most effective strategies to attract learners and enable them to create meaningful experiences [7][8]. With the changing face of education, which is presented by digital devices and a comprehensive active educational venue, the changing landscape is foreshadowing the educational experience in the future involving more gamification and interactivity as a means of teaching.

Gamification is made through the integration of the game mechanics into the educational environment, which should help to boost the motivation of the learners, retain knowledge, and enable the student-centered learning process [47]. With the help of Gamification elements, such as badges, points, leaderboard, quests, the educator can turn the classic learning environment into something interactive that creates intrinsic and extrinsic motivation. Such a method has been proven to be able to enhance the engagement of learners greatly with the research stating that gamified interventions have the potential to raise the engagement rates up to 60 percent [9][10][11].

Gamification methods are based on behavioral psychology and are aimed at developing completion, competition, and collaboration between learners. By utilizing fixed, objective-based exercises, the students are able to interact with the curriculum in a meaningful way which makes eLearning modules quite engaging to complete in nature [10][12][11].

Clear objectives, such as levels and leaderboards, enhance motivation by providing attainable targets for learners. The pursuit of these goals not only boosts performance but also fosters a sense of satisfaction and accomplishment as students strive for maximum results [13][11].

Gamified learning environments encourage social interaction and friendly competition, which can enhance group work and collaborative skills among participants. This social dimension is crucial for creating a community of learners who actively engage with one another, enriching the overall educational experience [13][14].

2.2 The metaverse in education

The Metaverse refers to a collective, digital, three-dimensional and interactive environment, which is created through the convergence of technologies such as virtual reality (VR), augmented reality (AR), high-speed networks and artificial intelligence (AI). It is a persistent and shared digital space, in which users, through their digital representatives (avatars), can interact with each other, with the environment and with information, in real time [40].

The metaverse can be accessed through a variety of technological devices, which offer different levels of immersion, depending on their technical characteristics and capabilities. The choice of device largely determines the quality of the user's experience in the virtual world, affecting both the sense of presence and the interaction with the environment. Metaverse access devices can be Computers, Mobile phones and tablets which provide access to basic 3D environments via a browser or special applications. Although the immersion is limited, they offer functionality and convenience, especially for educational scenarios [38]. They can also be Virtual Reality Devices (VR headsets): E.g. Oculus Quest, HTC Vive, Meta Quest Pro, which offer a high level of immersion, allowing the user to feel "present" in the virtual world through a 360° field of view, spatial audio and manual interaction. They are suitable for fully experiential learning experiences, but have a high cost and require adaptation to the user environment. They can also include Augmented Reality Devices (AR glasses): E.g. Microsoft HoloLens, Magic Leap that add digital objects on the real world so that it can merge real and virtual spaces. They may be applied to the case when one has to navigate in the physical space. Finally, mixed reality (MR) devices, which combine VR and AR features [45], offering the ability to interact with both physical and digital objects, creating a more natural and realistic experience [39].

The introduction of the metaverse in education also presents numerous positive attributes, including the fact that the elements of the metaverse strongly contribute to immersion and the ability of students to interact with each other in learning scenarios, which encourages their deeper comprehension of specific concepts. Moreover, the metaverse supports teamwork and socialization among the students no matter where they are located and fosters a feeling of community and encouragement among the learners. This has the capacity to make learning environments participatory and captivating where students are allowed to learn in virtual environments as well as perform simulations and solve problems [40].

Interestingly, being gamified, the use of virtual worlds in education opens a new possibility to design an immersive learning experience. These settings allow students to engage in realistic settings that allow critical thinking and problem solving. An example is the urban planning course whereby the student is capable of developing virtual cities which are designed in accordance with theoretical tenets hence will have an enhanced knowledge of the complex nature in the form of working practice [4][15].

The introduction of gamified elements in virtual learning spaces is closely tied to the cognitive, behavioral, and affective dimensions of engagement. Cognitive engagement refers to the depth of attention and retention of information, while behavioral engagement encompasses active participation and consistent attendance. Affective engagement focuses on the emotional aspects, such as motivation and passion for learning [15]. These interconnected dimensions are crucial for fostering an environment where students can thrive and develop essential skills for future challenges.

Gamification and metaverse technologies applied in education open new opportunities to increase students engagement and achieve better performance. Several techniques and tools have been formulated so as to capitalize on potential of those digital environments. In the example of Minecraft Education Edition, gamification is implemented extremely effectively and pedagogically wide, providing a student with the freedom to learn, experiment, deal with another player, and express his/her creativity. Using such platforms, teachers may develop exciting multimedia lessons that suit the various learning styles.

In education, gamification uses mechanisms, including points, badges and leaderboard to encourage students. These properties give an instant discrimination and reward thus promoting constant participation and competition among the students. Also, storytelling and narrative features may enhance educational experience and enable students to engage with the material more precisely. Moreover, inclusion of quest and challenges into the curriculum has the potential to replicate real world scenarios of problems thus, allowing the students to develop skill mentally with each successive and more challenging task [16]. The given approach not only makes the learning process interesting but it is also remembered and hence easier to retain.

Modern education is already moving forward to include the metaverse as the important element of the learning progress, and the new methods of learning it brings, will overcome the classical limitations of the classroom environment. This online platform allows the teachers to create some virtual world where learners can work and investigate different topics in an interactive manner [18]. As an illustration, it has been found out that metaverse-based education can largely improve the learning process, especially in such areas as civil engineering, where it is of ultimate importance to gain real-life experience [19]. In this regard, metaverse does not only increase accessibility to high-quality education, but also ensures collaboration among the students and educators regardless of their geographic location [6]. The metaverse can transform the education sector by allowing real-time communication and active learning environments and thus render learning more available as well as productive.

3. Methodological Approach

The research methodology used in the research study consists of a literature review that involves documents and records existing theoretical and empirical solutions and approaches to the integrating uses of gamification in virtual educational worlds of the metaverse. This was done through scientific databases, including Google Scholar, and Springer Link, where matching keywords, including, gamification in virtual worlds, educational metaverse, game-based learning, immersive learning environments, and VR in education, were searched. Sources were selected on the basis of relevance, validity and freshness (during the last five years), which reflects the desire to reflect current scientific knowledge and to register the pedagogical opportunities provided by the interaction of gamification and immersive technologies within the framework of the contemporary educational process.

The **research questions** guiding this study are the following:
1. How the metaverse incorporates gamification into educational virtual worlds?
2. What are the benefits of gamification in the metaverse?
3. What are the challenges of gamification in the metaverse?
4. What is the role of artificial intelligence in gamification in metaverse?
5. What are the guidelines for developing educational virtual worlds with added gamification?
6. What methodology is suitable for developing gamified virtual educational experiences in the metaverse?

4. Results of Study

Incorporating various game mechanics can significantly enhance student engagement and learning outcomes. These mechanics may include exploration, challenge and mastery dynamics, feedback loops, and discovery-based learning through interactive storytelling [21][22]. Features such as points, badges, and leaderboards serve as motivational tools, encouraging students to complete tasks and achieve goals while fostering a sense of competition and community among peers [23].

When designing a gamified online platform for education in a Metaverse context, it is important to document the educational goals, target audience, scope, and desired learning outcomes [24]. This initial step allows for the customization of the platform's design and functionality to align with specific educational visions.

One of the most important aspects in the success of an educational platform is the UX focus on design. It is necessary that the platform allows an easy navigation, interesting interfaces, and availability of content so as to establish a feasible learning environment to both the students and the teacher [25]. Sounds, animations, AI-produced drawings, and interactive storytelling are some of the things that make the learning experience more engaging, allowing the virtual world to establish stronger ties with students and the related material [21].

Student engagement would be enhanced by the use of interactive activities. Features such as drag-and-drop activities, memory games, and entertaining storytelling activities provide a variety of opportunities for students to engage in the learning process. For example, games where clues are hidden among objects that can be dragged will stimulate and encourage curiosity and exploration, while games that test memory will allow for practice and recall in a fun and visually eccentric way [21][26]. Custom animations and more complex engagement can also be utilized to make user experience to appear more visual and stimulating, resulting in an eye-pleasing learning experience [21].

Constant iteration and optimization put in place using user feedback and testing is also vital to the effectiveness of the gamification platform. Such iterating process will aid in finding and solving said issues and hence foster the overall quality and reliability of the educational experience [26].

By strategically selecting simulation tools that align with project requirements, developers can create realistic scenarios that enhance learning while also accommodating different user interactions and system conditions [26].

Gamification in educational environments of the metaverse combines techniques and mechanisms from game design with the capabilities of immersive technology, with the aim of enhancing student participation, motivation and learning experience. Through the use of 3D virtual worlds and interactive elements, the aim is to transform learning into an experiential, creative and collaborative process.

To achieve these goals, it is necessary to follow certain basic design principles.

First, the learning objectives should be clearly defined, so that the game elements support and do not distract from the educational process and do not cause increased cognitive load [60]. Each action or interaction in the game should enhance understanding and application of knowledge without unnecessary repetition and there should be a regular flow of the learning path [54].

Second, the immersive experience is a critical factor for success. The environment should allow for free exploration, the use of expressive avatars, and an emotional connection to the space, thus enhancing students' participatory disposition.

In addition, the gradation of the challenge and the progressiveness of the content play an important role. The use of difficulty levels, the gradual disclosure of material (unlockable content), and continuous real-time feedback offer a framework for motivation and self-regulation. At the same time, the inclusion of narrative structure and roles enhances engagement, as students feel that they are actively participating in a scenario with real meaning and purpose.

Another key element is the **social dimension.** Collaborative activities, group missions, and collective problem-solving develop communication, empathy, and teamwork skills. Rewards can be given for both individual performance and contribution to the group as a whole.

In terms of **application examples**, the metaverse offers opportunities for the full integration of gamified practices into different subjects. For example, in History, students can navigate reconstructed historical environments and participate in mystery-solving missions [38]. In STEM subjects, it is possible to create virtual laboratories with simulations and experiments. In Language and Literature, students can embody characters from works, experiencing the narrative through interactive scenarios [40].

Finally, important best practices include student participation in the design of activities (co-creation), personalized learning paths, and the integration of assessment through game-based tools (game-based assessment). Effectively designing such environments contributes to the transformation of learning into a process with meaning, personality, and deep internal motivation.

The educator to introduce gamification into the metaverse, can also utilize the **MDA (Mechanics – Dynamics – Aesthetics) framework**, which is one of the most widely used theoretical models for game analysis and design, and is widely applied to educational gamification, especially in environments such as the metaverse. It was developed by Hunicke, LeBlanc, and Zubek [62], with the aim of bridging the gap between the designer and the player, offering a common vocabulary and an approach that allows for the systematic development of a gamified experience. The MDA framework offers a structured design tool to create learning environments with substantial gamification. Success depends not only on adding games, but on aligning the mechanics with the intended learning dynamics and aesthetic experiences.

This framework distinguishes between mechanics, dynamics, and aesthetics in educational game development:

Mechanics are the basic rules, structures, and systems of the game – the elements that are evident in the code or at the design level. In the educational context, they include:

- Points or badge system
- Challenges and quests
- Time constraints
- Levels
- Interaction with objects or puzzles
- Built-in assessments or quizzes
- Progression or content "unlocking" system

In virtual environments of the metaverse (such as Spatial.io), mechanisms can be implemented through interactive widgets, teleportation portals, activation buttons, scripted objects, etc.

Dynamics concern the way mechanisms interact with players/students and with each other over time. That is, they arise from the behavior of players within the boundaries set by the mechanisms.

In educational games, dynamics can include:

- Cooperation or competition between students
- Decision-making based on consequences
- Negotiation, group problem solving
- Exploration / exploration of the environment
- Motivation for repetition or achievement of goals
- Emotional engagement with the world or narrative

Good design should anticipate how students will interact with the mechanisms and each other, in order to produce desired learning experiences.

Aesthetics is about how the game is experienced by the player. It is not only about the visual appearance, but mainly about the emotion and experience that is gained.

Some of the sensory experiences sought in educational gamification include:
- Curiosity and discovery
- Achievement and sense of progress
- Social connection and participation
- Fun and enjoyment
- Narration and identification with the role
- Sense of purpose and significance of the action
- Challenge and overcoming difficulties
- Autonomy and choices

Popular metaverse platforms, such as **Roblox** [42], **Minecraft Education Edition** [43], and **Fortnite Creative** [44], offer significant opportunities for integrating gamification into the educational context, leveraging the specific technical and pedagogical capabilities of each platform. Specifically, these platforms allow the construction of interactive virtual worlds, in which students can actively participate as creators and players, enhancing their collaboration, critical thinking, and engagement in the learning process. Through the use of gamification elements, virtual worlds are transformed into gamified learning environments with a high degree of immersion.

Specifically:
- On **Roblox**, users can develop educational games using the Lua language, leveraging creation tools to design missions, levels, and reward systems.
- On **Minecraft Education**, educators use ready-made scenarios or create their own, with built-in objectives and activities that cultivate skills such as problem solving, logic, and collaboration.
- **Fortnite Creative** and Unreal Editor for Fortnite (UEFN) allow the creation of complex interactive environments, where narrative elements, quests, and challenges with clear learning objectives can be integrated.

\The integration of gamification on these platforms substantially contributes to the transformation of the educational experience, supporting experiential and active forms of learning, and responding to the demands of the digital age and pedagogical innovation. The integration of gamification in Roblox [42] is done in a very dynamic and creative way, as the platform itself is built to support game-centered environments of learning and entertainment. Below are the main ways in which gamification is integrated into Roblox:

1. Game Mechanics: Roblox Studio allows creators to integrate a variety of game mechanics that are directly related to gamification, such as:
- Badges: Achievements awarded for specific actions.
- Leaderboards: Enhancing positive competition.
- Missions & challenges: Structured activities with rewards.
- Inventory & upgrades: Items that are unlocked as the user progresses.
- Points: Collecting points for achieving goal.
- Levels: Player progress through levels.

2. Educational Games with Gamification: Many educators create educational worlds in Roblox, where learning occurs through missions or adventures:
- STEM experiments with goals and rewards.
- Math escape rooms where each correct answer unlocks the next level.
- Historical quests, where students "travel" to virtual representations and solve problems.

3. Self-Directed Learning through Personal Development: Creating avatars, collecting items, and upgrading skills through ongoing missions provide autonomy and a sense of control, central elements of self-determination theory.

4. Collaboration and Social Interaction: Roblox allows for teamwork and real-time communication:
- Collaborative missions that require coordination.
- Shared constructions (e.g., student world creation).
- Role playing with educational scenarios.

5. Real-Time Feedback: Students see immediate results of their actions:
- Continuous progress updates with visual or audio effects.
- Praise, reward sounds, avatar changes.

6. Co-Creation Capability: Students themselves can be creators:
- Program and design their own games.
- Implement gamification mechanisms that they understand and choose.
- Collaborate as a production team (design, code, storytelling).

5. Discussion

5.1 Benefits of gamification in the metaverse

Gamification in education, particularly within virtual worlds in the metaverse, offers a range of significant benefits that enhance the learning experience for students and educators alike. These benefits can be categorized into several key areas: engagement, motivation, retention, and the development of soft skills [48].

Beyond academic benefits, gamification contributes to the development of essential soft skills. Many gamified experiences require teamwork, problem-solving, and critical thinking, which are crucial skills both in educational settings and in life [2]. For example, collaborative projects designed as gamified missions can enhance students' abilities to work together creatively, preparing them for future challenges in various environments [46]. Among the most remarkable benefits of gamification learning environments, it is possible to count the increased level of engagement among learners. The active and communicative experience of using such platforms makes the educational process more pleasant and motivates one to participate in the process longer-term in an active way [27][16].

Studies indicate that gamified approaches have yielded better engagement outcomes compared to traditional online learning methods, significantly improving student participation rates [28][29]. Gamification strategies utilize elements such as points, badges, and levels to create a sense of achievement and progress, which significantly boosts learner motivation [30][27]. This reward system reinforces positive behavior and recognizes individual achievements, effectively motivating learners to actively pursue their educational goals. As an example, the corporate training usually includes point-based rewards to motivate the people to progress through their training curriculum in the same manner, the educational environment also uses such aspects to keep the students motivated within the courses they are undertaking [30].

Gamified learning experiences are equally key to the improvement of knowledge retention and implementation [47]. These platforms keep learners informed better due to the element of quizzing, instant feedback, and the introduction of realistic situations [27][16].

It has also been shown that gamified learning has the potential to increase knowledge retention rates by 40%, which once again indicates the effectiveness of this method as one of the main educational tools. Furthermore, these approaches allow students to transfer knowledge to real-world situations, enhancing their understanding of what they have read and learned [16].

5.2 Challenges of gamification in the metaverse

The integration of gamification and virtual worlds in the metaverse presents several significant challenges that educators and institutions must navigate to effectively harness these technologies in educational settings. One of the primary challenges is the reliance on advanced technology and robust infrastructure. Many educational environments may not have consistent access to the necessary hardware or high-speed internet, which can hinder the effectiveness of gamified learning solutions [31]. The insufficient resources on the side of learners do not allow engaging in different interactive and immersive features of the courses in their full, which can diminish the engagement levels and learning results [32]. In addition, the additional expenses incurred in running and sustaining the immersive learning technologies serve to make this situation even more problematic, making it difficult to connect with less wealthy institutions [33].

The use of gamification in eLearning raises significant privacy and security concerns. Collecting and analyzing detailed user data is often necessary to personalize learning experiences, but this practice risks exposing sensitive information about learners' performance and behavior. Without stringent data protection policies and technologies, educational providers may face the threat of data breaches, leading to unauthorized access and a loss of trust among users. It is essential for institutions to implement robust security measures, such as data encryption and comprehensive privacy policies, to mitigate these risks [12].

Another critical challenge is ensuring accessibility and inclusivity in gamified educational environments. Adhering to universal design principles is vital to create content that is accessible to individuals with diverse abilities and disabilities. Such aspects as text sizes that can be adjusted, color contrast alternative methods of navigation should be implemented in advance, in order to provide further accessibility [31]. The testing with the

users with disabilities when conducted regularly will help gain feedback and provide the improvement of the learning experience on a continuous basis.

While gamification can motivate learners, it also poses the risk of overemphasizing competition, which may not be suitable for all educational contexts or learners. Competitive elements like leaderboards can demotivate some students, shifting focus from mastering the subject matter to merely outperforming peers, potentially undermining the overall educational objectives [12].

To build a more inclusive learning environment, educators should take into account cooperative gamification strategies, which encourage collaboration and identify various achievements. The risk of rise in the inequalities stands out as an ethical issue.

Metaverse education can be afforded only by wealthier schools or regions, further widening the gap between opportunities in education. There is also the privacy concern where certain platforms could collect biometric, and behavioral patterns, which can be misused [34]. The policymakers and organizations should collaborate to provide fair access to metaverse education and protection of student information.

The engrossing effect of the virtual world has the potential of causing physical discomfort to certain users such as causing motion sickness and eye strain, especially among students who are still young. Studies have also indicated that a significant proportion of VR users have reported distress after extensive use, and this poses a question against the long term impacts of these technologies to the well being of learners. Furthermore, excessive involvement in virtual environments can contribute to feelings of loneliness and addiction [63], particularly among children, necessitating careful consideration of how and when these technologies are utilized in educational contexts [31].

5.3 Development Methodology

Effectively integrating gamification into educational virtual worlds in the metaverse requires carefully designed and pedagogically informed programming. Specifically, the design of such environments should be based on the following key principles:

1. **Alignment with Instructional Objectives:** All elements of the game (reward mechanisms, challenges, missions, rules) should be fully aligned with the predetermined learning objectives and the curriculum. Gamification should not function in isolation or as an entertainment addition, but should be an organic part of the learning process that enhances cognitive engagement [53].
2. **Scaffolding:** Educational challenges within the virtual world should be adapted to the level of readiness of each student, in a way that maintains flow and avoids situations of either boredom or excessive stress. Dynamic difficulty adjustment contributes to self-regulated learning and the enhancement of self-confidence [54].
3. **Variety of Activities:** The virtual world should incorporate a rich range of activities, such as exploration, problem solving, experimentation, construction, collaboration with other players, etc., in order to cover different types of learning (visual, kinesthetic, analytical, social). This differentiation enhances personalization and encourages participation [55].
4. **Scalable Architecture:** The technical infrastructure of the environment should support simultaneous access by multiple users without sacrificing the user experience [61]. This is necessary to support collaborative learning activities, but also to generalize the application in broader educational contexts [56].
5. **Interoperability:** Educational virtual environments must be accessible from a variety of devices (e.g. computers, tablets, VR headsets), as well as compatible with different operating systems and platforms. This ensures the wider diffusion and adoption of these technologies, while reducing barriers to access [57].
7. **Analytics:** The use of learning path analysis tools is critical. Student performance data (engagement, progress, repetitions, in-game behaviors) provides valuable feedback to teachers and supports adaptive teaching [58].
8. **Data Security and Digital Ethics:** Protecting student privacy, personal data security and compliance with digital ethics principles (e.g. GDPR) are cornerstones in the design of such systems. Any educational platform requires the integration of reliable security protocols and responsible use of technologies [59].By incorporating these principles, educational virtual worlds can be transformed into high-quality learning ecosystems that enhance both knowledge acquisition and 21st century skills.

This study proposes the following **development methodology** (Fig. 1) which consists of five stages:
Stage 1: Needs and Objectives Analysis, where it is done:
- Investigation of learning needs.
- Definition of cognitive and metacognitive objectives (based on the Bloom model).

• Analysis of student characteristics (age, interests, technological readiness).

Stage 2: Design of a Gamified Virtual Environment, where it is done:
• Selection of a cognitive subject (e.g. Physics, History).
• Development of a scenario with a strong narrative.
• Integration of gamification elements: Points, leaderboard, missions, avatars, badges.
• Selection of a metaverse platform (e.g. FrameVR, Spatial, Mozilla Hubs, Unity 3D + VRChat).
• Design of collaboration mechanisms (team quests).

Stage 3: Development and Pilot Implementation, where it is done:
• Creation of a 3D environment.
• Implementation of a scenario through programming tools or no-code platforms.
• Pilot implementation with a volunteer group of students.
• Collection of initial data (observation, log files, short questionnaires).

Stage 4: Evaluation and Feedback, where it is done:
• Combination of quantitative (satisfaction questionnaires, performance levels) and qualitative evaluation (interviews, recording of experiences).
• Analysis of engagement, learning, technical performance, collaboration.
• Optimize the environment based on feedback.

Stage 5: Full Implementation and Dissemination, where it is done:
• Expand the environment to a wider learning population.
• Create a user manual and educational materials.
• Dissemination through conferences, educational communities or open educational resources.

A clearly defined development methodology acts as a guiding framework for design teams, leading to the creation of safer, pedagogically targeted, and technologically effective educational virtual worlds. By systematically organizing design phases, incorporating pedagogical principles, and anticipating technical and pedagogical challenges, this methodology helps ensure the quality, safety, and pedagogical credibility of learning experiences offered in the metaverse.

5.4 The role of AI
Artificial Intelligence (AI) is the driving force behind gamification in the metaverse, creating living, adaptive virtual worlds that evolve with user actions. AI powers characters that don't follow programmed scripts but react naturally to user actions. These characters can develop "personalities," remember past interactions, and create unique experiences for each user [49]. Virtual worlds use AI to create dynamic stories that change based on user choices and behavior. Each experience becomes unique as AI adapts the plot, characters, and challenges. Generative AI creates new environments, objects, textures, and even music that respond to user needs and preferences, keeping the world always fresh and interesting [50].

AI analyzes not only what the user does but also how they move in 3D space, how they interact with objects, how much time they spend in different areas. This data is used to create experiences that fit each person's unique "digital nature." AI algorithms monitor social dynamics in the virtual world, suggesting collaborations, creating competitive events, and shaping communities based on shared interests and skills. It coordinates all the senses – visual, audio, haptic feedback – to create integrated experiences that enhance the emotional connection to the virtual world. It predicts what the user will do next and prepares the virtual world accordingly – from preloading environments to preparing specific challenges that will keep them engaged [51].

AI-powered virtual worlds are beginning to recognize the emotional state of users through voice analysis, gestures, and behavioral patterns, tailoring the experience to enhance positive emotions, which aggregates data from thousands of users to create complex ecosystems that evolve collectively, where the actions of one community affect the entire virtual world. AI creates virtual labs, historical reenactments, and scientific simulations that adapt to the pace and learning style of each user, making education truly interactive [52].

The next generation of virtual worlds will use advanced AI to create truly "living" environments that learn, evolve, and develop their own "culture" based on the collective interactions of users. This will lead to metaverses that are not just digital copies of reality, but truly alternative worlds with their own rules, economies, and social structures.
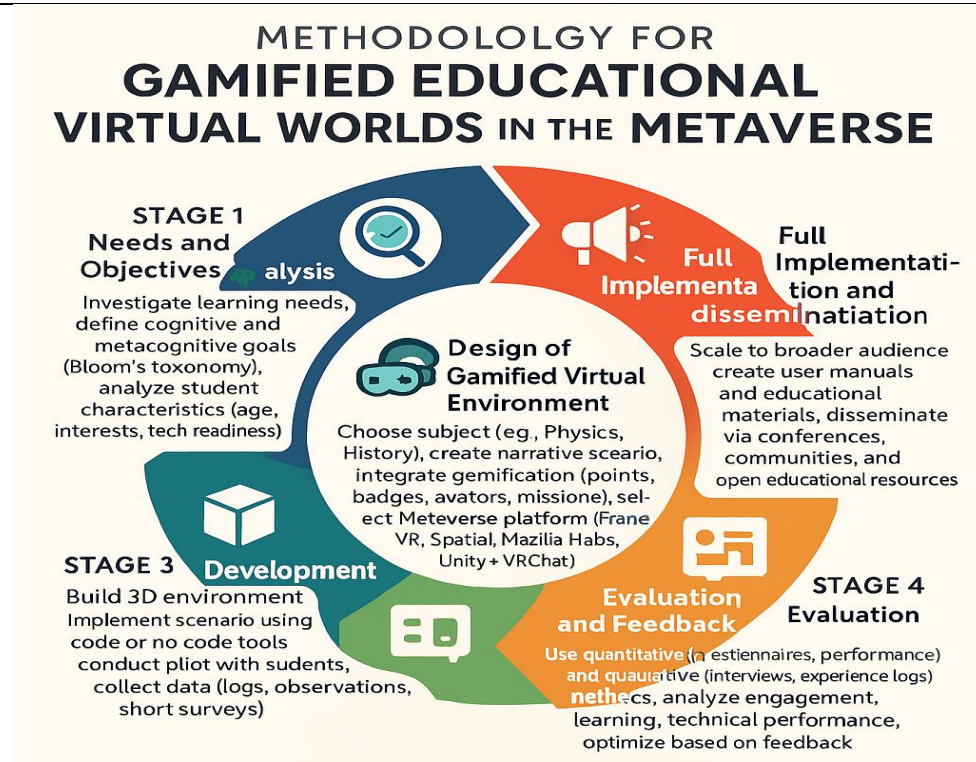
Figure 1: Proposed methodology for developing educational virtual worlds with gamification

6. Conclusion

Particularly, the employment of game mechanics in the educational metaverse virtual worlds offers a strong potential of enhancing the educational process. The pedagogic and technological difficulties notwithstanding, participation, understanding and improvement of skills is undeniable.

An integrated implementation model is needed to implement this successfully that involves technological innovation, pedagogical experience and social responsibility in a manner which is compatible. The teaching institutions need to develop and exercise teachers through training, build relevant infrastructure and design quality material.

The gamification of learning through virtual worlds in the metaverse carries several risks, such as the risk of over-reliance on technology, the reduction of human interaction, the risks of excessive focus on rewards and scores. Furthermore, the use of the metaverse in education causes risks that include physical health problems such as nausea and eye strain, risks of social isolation [63] and loss of contact with reality, concerns about the safety of users in virtual environments.

As technology advances and the practice of using such instruments grows, educational virtual worlds can change how it is possible to learn and teach making this experience more fascinating, efficient and meaningful. However, their effective utilization in the educational process will occur when the inherent risks are addressed and the various obstacles are overcome by applying gamification to the metaverse.

The rapid development of artificial intelligence will also enable more personalized learning experiences, while improvements in augmented reality will create more natural interactions.

The wider adoption of these technologies will require new approaches to education policy and teaching, as well as new standards for assessing learning.

References

[1]. Lingio. (n.d.). *All you need to know about gamification in education*.
https://www.lingio.com/blog/gamification-in-education
[2]. EdApp. (n.d.). *Gamification in education: Using games to enhance learning*. https://staging-site.edapp.com/elearning-gamification
[3]. Nudge. (2025). *Top 10 gamification tools in education for 2025*.
https://www.nudgenow.com/blogs/gamification-strategies
[4]. TeachThought. (2023). *20 uses for virtual worlds in the classroom*.https://www.teachthought.com/the-future-of-learning-posts/virtual-worlds/

[5]. TalentLMS. (n.d.). *Gamification in education: Pros, cons, and practical insights*.

[6]. Meta. (n.d.). *How the metaverse can transform education*. Mixed reality in education | Meta for Work

[7]. Çelik, F., & Baturay, M. H. (2024). The effect of metaverse on L2 vocabulary learning, retention, student engagement, presence, and community feeling. *BMC psychology,* 12(1), 58.

[8]. SoluLab. (2023). *The impact of the metaverse on education and learning*. https://www.solulab.com/impact-of-metaverse-on-education-and-learning/

[9]. eLearning Industry. (2023). *Gamification for learning: Strategies and examples*. https://elearningindustry.com/gamification-for-learning-strategies

[10]. Kapp, K. M. (2012). *The gamification of learning and instruction: game-based methods and strategies for training and education*. John Wiley & Sons.

[11]. Rivera, E. S., & Garden, C. L. P. (2021). Gamification for student engagement: a framework. *Journal of further and higher education*, *45*(7), 999-1012.

[12]. Ghoulam, K., Bouikhalene, B., Babori, A., & Falih, N. (2024). Gamification in e-learning: bridging educational gaps in developing countries. *International Journal of Advanced Corporate Learning*, *17*(1), 85.

[13]. Drimify. (n.d.). *Applying gamification to virtual reality*. https://drimify.com/en/resources/applying-gamification-virtual-reality/

[14]. ERYLMAZ, Y., & Boicu, M. (2023). The Impact of Gamification on Motivation and Engagement in Game-based Learning Environments-A Literature Review. *Journal of Student-Scientists' Research*, *5*.

[15]. Lin, X. P., Li, B. B., Yao, Z. N., Yang, Z., & Zhang, M. (2024). The impact of virtual reality on student engagement in the classroom–a critical review of the literature. *Frontiers in Psychology*, *15*, 1360574.

[16]. Lee, M., Shin, S., Lee, M., & Hong, E. (2024). Educational outcomes of digital serious games in nursing education: a systematic review and meta-analysis of randomized controlled trials. *BMC Medical Education*, *24*(1), 1458.

[17]. Roundup. (2024). *Top 12 gamified learning platforms for trainers*. https://slideswith.com/blog/top-gamified-learning-platforms

[18]. Zhao, X., Ren, Y., & Cheah, K. S. (2023). Leading virtual reality (VR) and augmented reality (AR) in education: bibliometric and content analysis from the web of science (2018–2022). *Sage Open*, *13*(3), 21582440231190821.

[19]. Afacan, N. M. (2023). Gamification in metaverse. In *Metaverse: technologies, opportunities and threats* (pp. 187-202). Singapore: Springer Nature Singapore.

[20]. Smiderle, R., Rigo, S.J., Marques, L.B. *et al.* The impact of gamification on students' learning, engagement and behavior based on their personality traits. *Smart Learn. Environ.* 7, 3 (2020). https://doi.org/10.1186/s40561-019-0098-x

[21]. Classcraft. (n.d.). *Free gamification platform: Create game-based materials in minutes*. https://www.classcraft.com/

[22]. Clark, R. C., & Mayer, R. E. (2023). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. john Wiley & sons.

[23]. Deloitte Insights. (2023). *How gamified learning increases engagement in higher education*. https://www2.deloitte.com/

[24]. Tsiliakos, M., & Bassing, S. (2024, April). Eduverse: Exploring Gamification and the Metaverse in Architectural Pedagogy. In *ACCELERATED DESIGN, Proceedings of the 29th International Conference of the Association for ComputerAided Architectural Design Research in Asia (CAADRIA) 2024, Volume 3, 59-68* (pp. 59-68). Association for Computer-Aided Architectural Design Research in Asia (CAADRIA).

[25]. Williams, K. (2023). *What does metaverse education have in store for humanity? Futures in Education*, https://program-ace.medium.com/what-does-metaverse-education-have-in-store-for-humanity-a2d9930b511f

[26]. eLearning Industry. (2024). *Top virtual reality training software features for interactive learning*. https://elearningindustry.com/vr-training-software-features

[27]. Centrical. (2024). *Gamification for learning: 7 strategies for success*. Enterprise Gamification Platform - Gamify employee training | Centrical

[28]. Maryana, M., Halim, C., & Rahmi, H. (2024). The impact of gamification on student engagement and learning outcomes in mathematics education. *International Journal of Business, Law, and Education*, *5*(2), 1697-1608.

[29]. Li, D., & Jianxing, W. (2025). The effect of gamified learning monitoring systems on students' learning behavior and achievement: an empirical study. *Entertainment Computing*, *52*, 100907.

[30]. Lampropoulos, G., Kinshuk Virtual reality and gamification in education: a systematic review. *Education Tech Research Dev* 72, 1691–1785 (2024). https://doi.org/10.1007/s11423-024-10351-3

[31]. Mercan, G., & Selçuk, Z. V. (2024). The Role of Metaverse Technology in Education: A Systematic review of opportunities, challenges, and educational potential. *Sakarya University Journal of Education*, *14*(2), 360-375.

[32]. Cha, S. S., Kim, C. Y., & Tang, Y. (2024). Gamification in the Metaverse: Affordance, perceived value, flow state, and engagement. *International Journal of Tourism Research*, 26(2), e2635.

[33]. Muzata, A. R., Singh, G., Stepanov, M. S., & Musonda, I. (2024, November). Immersive learning: A systematic literature review on transforming engineering education through virtual reality. In *Virtual Worlds* (Vol. 3, No. 4, pp. 480-505). MDPI.

[34]. Fenu, G., Marras, M., & Boratto, L. (2018). A multi-biometric system for continuous student authentication in e-learning platforms. *Pattern Recognition Letters*, *113*, 83-92.

[35]. Li, M., Ma, S., & Shi, Y. (2023). Examining the effectiveness of gamification as a tool promoting teaching and learning in educational settings: a meta-analysis. *Frontiers in Psychology*, *14*, 1253549.

[36]. Sripan, T., & Jeerapattanatorn, P. (2025). Metaverse-based learning: A comprehensive review of current trends, challenges, and future implications. *Contemporary Educational Technology*, *17*(3), ep584.

[37]. Skillscaravan (2025). Top *5 types of gamification training for employee engagement*. https://www.skillscaravan.com/post/types-of-gamification-training-for-employee-engagement

[38]. Magetos, D., Kotsifakos, D., & Douligeris, C. (2023, November). Educational Virtual Worlds for Vocational Education and Training Laboratories. In *2023 8th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (pp. 1-6). IEEE.

[39]. Mitropoulos, S., & Magetos, D. (2024, October). Incorporating metaverse technology into the adult distance learning process for open universities. Paper presented at I·HE2024, Limassol, Cyprus. https://doi.org/10.5281/zenodo.14220974

[40]. Magetos, D., & Mitropoulos, S. (2025, July). The metaverse in education: A literature review. International Journal of Latest Research in Engineering and Technology (IJLRET), 11(6), 48–58. https://doi.org/10.56581/IJLRET.11.06.48-58

[41]. Magetos, D., & Mitropoulos, S. (2025). *Effectiveness of educational virtual worlds in the metaverse: A study based on the ARCS model*. *International Journal of Latest Engineering Research and Applications (IJLERA)*, 10(6), 1–10. DOI:10.56581/IJLERA.10.6.01-10

[42]. Roblox Corporation. (n.d.). Roblox education. https://education.roblox.com

[43]. Mojang Studios & Xbox Game Studios. (n.d.). *Minecraft: Education Edition*. Microsoft. https://education.minecraft.net

[44]. Epic Games. (n.d.). *Fortnite Creative*. https://www.fortnite.com/creative

[45]. Seralidou, E., Karousou, M., & Douligeris, C. (2024, May). An AR Application for Mobile Devices to Support the Educational Process in Greek Secondary Education. In *2024 IEEE Global Engineering Education Conference (EDUCON)* (pp. 1-7). IEEE.

[46]. Seralidou, E., & Douligeris, C. (2021, September). Motivating students in distance programming learning using games. In *2021 6th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM)* (pp. 1-7). IEEE.

[47]. Kassi, D., Sarlis, I., Kotsifakos, D., & Douligeris, C. (2022, October). An educational cultural game for an industrial urban landscape. In *21st European Conference on e-Learning ECEL 2022* (p. 171).

[48]. Dochtsi, E.R., Kotsifakos, D., Douligeris, C. (2021). An Escape Room Game for Learning Digital Electronics in Vocational Education and Training (VET). In: Auer, M.E., Tsiatsos, T. (eds) Internet of Things, Infrastructures and Mobile Applications. IMCL 2019. Advances in Intelligent Systems and Computing, vol 1192. Springer, Cham. https://doi.org/10.1007/978-3-030-49932-7_62

[49]. Suresh Babu, S., & Dhakshina Moorthy, A. (2024). Application of artificial intelligence in adaptation of gamification in education: A literature review. *Computer Applications in Engineering Education*, *32*(1), e22683.

[50]. Tolks, D., Schmidt, J. J., & Kuhn, S. (2024). The role of AI in serious games and gamification for health: scoping review. *JMIR Serious Games*, *12*(1), e48258.

[51]. Kumar, D., Haque, A., Mishra, K., Islam, F., Mishra, B. K., & Ahmad, S. (2023). Exploring the transformative role of artificial intelligence and metaverse in education: A comprehensive review. *Metaverse Basic and Applied Research*, (2), 21.

[52]. Soliman, M. M., Ahmed, E., Darwish, A., & Hassanien, A. E. (2024). Artificial intelligence powered Metaverse: analysis, challenges and future perspectives. *Artificial Intelligence Review*, *57*(2), 36.

[53]. Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher education*, *32*(3), 347-364.

[54]. Csikszentmihalyi, M., & Csikzentmihaly, M. (1990). *Flow: The psychology of optimal experience* (Vol. 1990, p. 1). New York: Harper & Row.

[55]. Gardner, H. E. (2000). *Intelligence reframed: Multiple intelligences for the 21st century*. Hachette Uk.

[56]. Bruner, J. S. (1997). The culture of education. In *The culture of education*. Harvard university press.

[57]. Rose, D. H., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning*. Association for Supervision and Curriculum Development, 1703 N. Beauregard St., Alexandria, VA 22311-1714 (Product no. 101042: $22.95 ASCD members; $26.95 nonmembers).

[58]. Long, P., & Siemens, G. (2011). Penetrating the fog: Analytics in learning and education. *EDUCAUSE Review (Online)*.

[59]. Ribble, M. (2015). *Digital citizenship in schools: Nine elements all students should know*. International Society for technology in Education.

[60]. Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive science*, *12*(2), 257-285.

[61]. Mayer, R. E. (2005). Cognitive theory of multimedia learning. *The Cambridge handbook of multimedia learning*, *41*(1), 31-48.

[62]. Hunicke, R., LeBlanc, M., & Zubek, R. (2004, July). MDA: A formal approach to game design and game research. In *Proceedings of the AAAI Workshop on Challenges in Game AI* (Vol. 4, No. 1, p. 1722).

[63]. Bhargava, V. R., & Velasquez, M. (2021). Ethics of the attention economy: The problem of social media addiction. *Business Ethics Quarterly*, *31*(3), 321-359.