

Virtual challenges and real successes: videogames as educational tools

Monica Di Domenico ¹, Fabrizio Schiavo ², Tonia De Giuseppe ³ and Pio Alfredo Di Tore ²

- ¹ University of Salerno; modidomenico@unisa.it;
² University of Cassino and Southern Lazio; fabrizio.schiavo@unicas.it;
pioalfredo.ditore@unicas.it
³ Giustino Fortunato University; t.degiuseppe@unifortunato.eu
* Correspondence: modidomenico@unisa.it

Abstract: In recent decades, video games have emerged as a dominant form of entertainment, surpassing other traditional forms such as film and television in popularity. In parallel, their potential as educational tools has increasingly attracted the attention of researchers, educators and instructional designers. Recent studies suggest that video games can foster active learning, promote problem-solving and stimulate complex cognitive skills in ways that traditional methodologies often fail to do. This article explores the intersection of game design and pedagogy, with a particular focus on how video games can be integrated into education to enhance learning processes.

Keywords: videogame; edugame; game design; learning processes.

1. Learning theory in videogames

Videogames are unique tools in education because of their ability to combine interaction, feedback and immersion. The embedding of videogames in education is based on powerful learning theories that highlight how games can facilitate knowledge construction and skill development in an engaging way. Studies such as Gee's (2003) show that videogames incorporate essential didactic principles, including situated learning, intrinsic motivation and the interconnection between action and perception. Through these principles, videogames support active learning processes, which is more natural and lasting than traditional passive learning.

1.1 Situated learning and well-ordered problem contexts.

Situated learning refers to an approach that emphasizes the construction of knowledge through direct and meaningful experiences. This model recognizes that learning does not occur in the abstract, but in real or simulated situations that contextualize information, making it more accessible and applicable to the learner (Brown, Collins, & Duguid, 1989). In videogames, players explore interactive envi-



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ronments where they are called upon to solve challenges that often require creativity and critical thinking. A practical example is Minecraft, which allows players to build and explore environments, developing spatial planning and problem-solving skills in a playful context that simulates reality.

The presence of well-ordered problems, i.e., challenges organized in such a way that difficulty levels increase progressively, is another crucial aspect. This structure allows players to progress in a linear fashion, consolidating acquired skills and applying them in increasingly complex tasks. This method has direct implications for education, as it supports sequential and modular learning, as confirmed by the studies of Anderson et al. (2004), who demonstrated how learning through graded challenges is effective in improving cognitive and problem-solving skills.

1.2 Intrinsic motivation and active engagement

A key element that makes videogames powerful educational tools is their ability to generate high intrinsic motivation. In videogames, interest and the desire to achieve new goals emerge from the very enjoyment of the activity, without the need for external rewards. Deci and Ryan (2000) have shown that intrinsic motivation leads to more robust learning outcomes than extrinsic motivation, and video games, with their appealing design and progressive challenges, provide a perfect example of how these principles can be applied.

In particular, video games often use challenge mechanics and immediate feedback to maintain player engagement. Any progress, large or small, is recognized and rewarded through scores, levels, or bonuses, reinforcing the determination to continue. This principle is aligned with Csikszentmihalyi's (1990) "flow theory" according to which the optimal experience is achieved when people are fully engaged in an activity. Flow represents a state of intense concentration that occurs when the difficulty of the task is well balanced against the individual's abilities, a balance that video games manage to create very effectively.

1.3 Action and perception: the role of manipulation and Experiential Learning

Another crucial educational principle in videogames is the interconnection between action and perception, which is the core of experiential learning. According to Dewey (1938), learning is most effective when the individual is directly involved in experiences that stimulate reflection and understanding. In videogames, this connection is present as players actively manipulate the game environment to advance, solving puzzles and facing obstacles that require immediate reasoning and strategic decisions. This direct participation stimulates both motor and cognitive skills, promoting dynamic learning.

Manipulating the game environment makes the learning process more immersive and engaging, and improves information processing. Neuroscientific studies, such as those conducted by Barsalou (1999), show that active manipulation of objects in the virtual world activates areas of the brain related to memory and spatial understanding, promoting the construction of lasting meanings. In an educational context, this practice is useful for developing critical thinking and the ability to deal with problems independently, skills that are critical for success in school and work.

1.4 Collaborative learning and social skills

Many modern videogames include social components that encourage cooperation among players. Online game environments, for example, allow students to collaborate with other users to achieve common goals, developing communication and collaboration skills. According to Vygotsky (1978), social interaction is essential for learning, as it enables individuals to learn not only through direct experience, but also by observing and interacting with others.

In this context, videogames that involve team play, such as *World of Warcraft* or *Fortnite*, offer unique opportunities to improve social and leadership skills. Students learn to share strategies, resolve conflicts and rely on others' skills to overcome challenges. This type of collaborative learning has been associated with increased problem-solving skills and growth in interpersonal communication skills (Salen & Zimmerman, 2004).

2. Educational design inspired by videogames

Successful videogames not only entertain, but are also designed in a way that facilitates learning and the growth of players' cognitive and social skills. The design principles used by game designers, including graded learning, immediate feedback, and the use of narratives, contribute to transforming games into engaging and interactive learning experiences. These elements can be translated into teaching methodologies that take advantage of students' natural interest in play and interaction.

An essential element of videogame design is progressive learning, which introduces information gradually, making it easier for players to master the new skills required as the game progresses. This principle, often called “scaffolding” in the educational field, allows players to build their understanding by starting with basic skills and advancing to more complex skills (Gee, 2003). Games such as *Portal* and *The Legend of Zelda* introduce new mechanisms and challenges incrementally so that players can learn each concept before applying it in increasingly difficult contexts. In an educational context, the scaffolding model is advantageous because it allows students to assimilate information gradually, reducing stress and increasing learning effectiveness (Sawyer, 2006).

In videogames, moreover, feedback is immediate: every action has a visible consequence that informs the player about the effectiveness of decisions. This type of feedback, which may include scores, level advancements, or animations, reinforces correct behavior and motivates the player to continue playing and improving. Immediate feedback has been shown to be a key factor in maintaining high student motivation and supporting active learning (Shute, 2008). For example, educational games can use a scoring system or visual rewards to recognize user progress, creating a positive learning environment that stimulates self-efficacy and autonomy.

Another crucial aspect of videogame design is storytelling, which makes learning more engaging and meaningful. Storytelling creates a context in which the player's activities have purpose and direction, fostering deeper and more enduring understanding. Bruner's (1991) research points out that the human brain tends to remember information presented in story form better because storytelling provides a structured framework that facilitates organizing information and making connections between concepts.

Videogames such as *Assassin's Creed* place players in realistic historical contexts, allowing them to explore cultures and environments from different eras. This approach facilitates situated learning that not only transfers specific knowledge, but also

stimulates curiosity about the subject matter (Squire, 2011). In formal education, using meaningful stories and contexts can help students connect new information to their own experience, increasing the relevance and value of learning.

Videogames set specific and sequential goals that guide players through the learning journey. Each level of the game has well-defined objectives, which provide players with clear direction and help them monitor their progress. This method not only improves motivation, but also stimulates autonomy and self-regulation skills, key elements of effective learning (Pintrich, 2004). Self-determination theory (Deci & Ryan, 2000) suggests that clear and achievable goals increase intrinsic motivation as individuals feel competent and in control of their actions. In education, setting specific and gradual goals allows students to manage and monitor their own learning, developing skills that foster self-efficacy and resilience.

In videogames, learning is an experiential process that requires players to test hypotheses, solve problems and adapt to new situations in real time. This form of learning is particularly effective because it allows learners to deal with complex situations and develop problem-solving skills through active, iterative practice (Kolb, 1984). Games such as *Civilization* or *SimCity* offer players the opportunity to experience complex social and environmental dynamics, pushing them to find solutions to large-scale problems, such as resource management or infrastructure construction.

The value of experiential learning lies in its ability to convey abstract concepts through hands-on experiences, helping students internalize knowledge and skills (Kolb & Kolb, 2005). Applied to education, experiential learning promotes an active and deliberate approach to problem solving, facilitating the development of critical and autonomous thinking that is essential in the education of students.

Finally, a unique aspect of many educational videogames is the ability to customize the game experience to fit each player's individual needs. The most advanced games use adaptive learning systems to modify the difficulty of the game according to the player's abilities and preferences, thus providing a tailored learning experience. This concept is particularly relevant in education, as personalization allows students to learn at their own pace, focusing on the areas where they most need support (Shute & Zapata-Rivera, 2012).

Research on personalized learning systems has shown that content adaptation can greatly improve learning and motivation as students receive specific, personalized feedback that helps them overcome difficulties (Horn, 2008). Through a personalized learning system, video games can ensure that students do not feel overwhelmed or bored, keeping interest and motivation high.

3. Case studies and practical applications

The use of videogames in education has attracted the interest of many researchers, who have pointed out that games can be a powerful tool for fostering active and engaging learning. The following case studies demonstrate how video games can improve specific skills and facilitate learning of traditionally complex subjects by stimulating students' motivation and engagement.

3.1 Case Study 1: videogames and mathematics learning.

One of the areas in which videogames have shown a positive impact is in mathematics learning. Ke (2008) studied the effect of educational math games on a group of elementary school students using a game designed to teach basic arithmetic

skills. Math problems were presented in the form of incremental challenges, and players could earn points and advance in level by passing different arithmetic tasks. Results showed that students who used the video game scored significantly higher on math tests than the control group, demonstrating an improvement in numerical skills.

In another study, Carr (2012) examined the use of the game *DragonBox*, designed to teach the fundamental concepts of algebra. This game turns algebraic equations into visual puzzles, reducing the anxiety often associated with learning mathematics. After a few weeks of use, students reported increased understanding and confidence with algebraic concepts, making *DragonBox* an effective tool for improving basic math skills.

3.2 Case Study 2: learning history through interactive simulations.

Learning history, which is often abstract and distant for many students, can benefit from the use of interactive simulations that provide an immersive experience. Squire (2004) conducted a study on the use of *Civilization III*, a strategy game based on historical events, to teach children historical and geopolitical concepts. Students who played *Civilization III* showed a deeper understanding of historical complexity, better understanding concepts such as trade, diplomacy, and conflict.

In addition, McCall (2016) analyzed the use of *Assassin's Creed* to teach Medieval and Renaissance history. This game, which recreates realistic historical settings, allows students to explore historical cities and settings, providing visual and interactive learning. The study found that students who played *Assassin's Creed* had a greater awareness of historical and geographical details than students who had studied the same material through traditional methods. The opportunity to “experience” history made learning more engaging and challenging, leading to increased motivation.

3.3 Case Study 3: Enhancing language skills with videogames

Videogames have also been successfully used to improve language skills. *Duolingo*, a game that uses interactive learning techniques to teach new languages, has been shown to facilitate the learning of vocabulary and grammatical structures. Vesselinov and Grego (2012) conducted a study of a group of adults who used *Duolingo* to learn Spanish and found that participants improved their language skills in a manner equivalent to that of a university language course.

Another example is narrative games such as *The Sims*, which offer immersive environments and dialogues in different languages. Peterson (2012) examined the use of *The Sims* to teach English to second-language learners, finding that players tended to improve their vocabulary and understanding of everyday language. The interactive and narrative component of the game facilitated language learning, as students were motivated to understand the dynamics of the game and progress.

3.4 Case Study 4: Science skills development with simulation games.

Science has also benefited from the introduction of videogames as teaching tools. *Spore*, a game that simulates the biological evolution of a species, has been used to teach evolutionary biology concepts to high school students. Barab et al. (2009) observed that students using *Spore* were better able to understand complex concepts such as natural selection and adaptation. The game allowed students to explore and manipulate different evolutionary traits, gaining direct experience with theoretical concepts.

Similarly, *Foldit*, a science game that allows players to manipulate protein structures, has proven to be an effective tool for teaching molecular biology concepts. Cooper et al. (2010) reported that *Foldit* players not only improved their understanding of biological structures, but also contributed to scientific research by discovering protein configurations that could have real value to science. This approach not only facilitates learning but also allows students to feel involved in scientific research.

3.5 Case Study 5: Improving social skills and collaboration through Online Role Playing Games.

In addition to academic matters, videogames have also been shown to improve students' social and collaborative skills. Online role-playing games such as *World of Warcraft* provide an environment in which players must work together to achieve common goals. Yee (2006) found that *World of Warcraft* players developed leadership skills, learned to resolve conflicts and improved their ability to cooperate with others.

Nardi and Harris (2006) observed that the social component of online role-playing games fosters interaction between individuals of different cultures, improving tolerance and cross-cultural understanding. These games require players to constantly communicate with each other, solve problems together and coordinate their actions, skills that are useful not only in academics, but also in daily life and future work experiences.

4. Criticisms and challenges to the use of videogames in education

Although videogames offer numerous advantages as educational tools, there are also various challenges and criticisms regarding their use in school settings. Key concerns include the risk of addiction, the possibility of games distracting students from educational goals, the costs associated with implementing videogames in schools, the difficulties of embedding them in traditional curricula, and ethical and methodological issues related to the assessment of learning.

One of the most common criticisms concerns the risk that videogames can be addictive and distracting, distracting students from their main educational goals. Gentile et al. (2011) pointed out that videogames, especially commercial ones, can develop a high level of engagement that can turn into behavioral addiction, especially in young people. The risk is that some students may spend too much time on videogames at the expense of school and social activities, leading to reduced academic performance and less participation in non-virtual activities.

The high level of stimulation and reward system of videogames may contribute to the phenomenon of “running away” from educational tasks and social relationships. In addition, distraction can be a significant problem, as educational games, if not structured and carefully monitored, can lose their educational effectiveness in favor of the play aspect. However, some scholars argue that if used in a controlled and balanced way, educational video games can be integrated without risk of addiction and distraction (Weinstein, Przybylski, & Murayama, 2017).

Embedding videogames within school curricula is a significant challenge for schools and educators. Creating curricula that effectively incorporate video games requires a rethinking of traditional teaching methods and the need to train teachers in the use of digital technologies in classrooms (Egenfeldt-Nielsen, 2007). Many schools and teachers are not yet prepared to adopt this innovative approach because they lack the necessary resources and technical support.

In addition, not all videogames are easily adaptable to the specific educational objectives of each discipline. Subjects that require direct instruction, such as grammar and advanced mathematics, may be difficult to integrate through video games, which may not fully meet learning needs. This lack of adaptability is one of the main barriers to implementing video games in formal educational settings and often involves revising curricula and assessment methods, which requires additional resources and specialized expertise.

Another aspect that should not be underestimated concerns the implementation of educational videogames, which can entail high costs, both in terms of purchasing software licenses and purchasing hardware equipment such as computers, tablets, or game consoles. These costs represent a significant barrier, especially for schools with limited budgets. According to an analysis by Fleer (2017), many educational institutions cannot afford to provide every student with access to the technology needed to use videogames in the classroom, creating inequality of access to digital resources.

Resources needed to implement videogames also include technical support and trained staff to effectively manage and monitor gaming programs. Some schools may face hidden costs, such as equipment maintenance and periodic software upgrades. This reality has raised questions about the equity of access to digital education and the risk of widening the gap between schools with different budgets (Selwyn, 2016). Therefore, it is important that the adoption of videogames in education takes these inequalities into account to ensure that all students can benefit from new educational technologies.

The use of videogames for educational purposes also raises ethical issues, such as the protection of students' personal data, and difficulties related to the assessment of learning. Many videogames collect information about users' performance to adjust the difficulty level or personalize the game experience. However, this data must be carefully managed to ensure student privacy and comply with data protection regulations (Livingstone, 2014).

Another major challenge is the assessment of learning. Traditional assessment methods, such as standardized tests, may not be able to effectively measure skills developed through videogames, such as problem-solving, creativity, and social skills. According to Klopfer et al. (2009), in order to properly assess the benefits of game-based learning, it is necessary to develop assessment methods that can measure more complex skills and reflect the multidimensional skills that students acquire through play.

An additional ethical issue concerns the influence that video games may have on students' psychological development. Some studies raise concerns about how video game content may influence students' values and behaviors. For example, simulation games, if not structured properly, could lead to a distorted view of reality or encourage aggressive behavior (Ferguson, 2015). Therefore, it is critical that educators carefully select games based on the educational content and values they wish to convey.

Another significant barrier to the adoption of videogames in education is the resistance to change from some educators and institutions themselves. Traditional teaching methods, based on frontal instruction and direct control, are deeply rooted in many educational cultures, and the transition to a more interactive approach, mediated by videogames, requires a transformation that not all teachers are prepared to undertake (Papert, 1993). Some educators may view videogames as a distraction rather

than an opportunity, or they may have a limited understanding of digital technologies and their educational potential.

Furthermore, cultural barriers could affect the acceptance of video games in classrooms. In some cultures, the use of video games is still perceived negatively, primarily associated with entertainment and not considered a valid educational tool. Cultural resistance and a lack of awareness of the potential benefits of educational video games call for specific training programs and increased awareness of the opportunities offered by digital learning (Selwyn, 2016).

5. The future of videogames in education

The future use of videogames in education is closely tied to the development of innovative technologies such as virtual reality (VR), augmented reality (AR), artificial intelligence (AI), and the metaverse. These technologies open up new possibilities for creating highly interactive, personalized, and immersive learning environments, offering even greater student engagement potential compared to current educational games. The following trends represent possible developments and challenges that will shape the evolution of educational video games in the coming years.

5.1 *Virtual Reality and Augmented Reality in Education*

Virtual reality (VR) and augmented reality (AR) are emerging technologies that allow students to immerse themselves in interactive three-dimensional environments where they can explore complex concepts and phenomena in a direct and tangible way. VR enables students to experience realistic scenarios in simulated environments, making experiential learning possible even when it would not be feasible in real life. For instance, through VR, students can explore the human body, interact with organs and biological systems, or participate in simulations of scientific experiments without the risks and costs associated with a real laboratory (Merchant et al., 2014).

Augmented reality, on the other hand, overlays digital information onto the real world, integrating knowledge with the physical environment in an interactive way. AR-based educational games can be used to bring three-dimensional elements directly into classrooms, such as interactive maps, anatomical models, and other visualizations. For example, an AR app could allow students to visualize chemical elements in 3D during a chemistry lesson. This multisensory learning approach enables students to observe, touch, and manipulate information in ways that enhance comprehension and retention (Dunleavy, Dede, & Mitchell, 2009).

These technologies have immense potential to revolutionize how students learn, transforming theoretical knowledge into practical and immersive experiences. However, large-scale implementation of VR and AR in education still faces challenges related to costs, device availability, and the need to train teachers to use these technologies effectively.

5.2 *The Metaverse and Collaborative Learning*

The concept of the metaverse refers to a shared, persistent, and interactive virtual space where users can interact with each other and the virtual environment. Although the metaverse is still under development, its potential application in education could open up new opportunities for collaborative and participatory learning. In the metaverse, students could attend virtual classes, collaborate on group projects, and experience real-time learning in immersive and interactive environments.

Learning in the metaverse could include environments simulating real-life scenarios, such as scientific laboratories, historical classrooms, or virtual museum visits, where students can interact with educational content and resources alongside their peers. Dede (2009) highlighted that engagement in immersive learning environments can improve problem-solving skills and promote deeper learning through interactivity and direct experimentation. In this context, the metaverse can also support the development of social and communication skills, facilitating collaboration among students from different cultures and languages in a virtual environment that transcends geographical boundaries.

Despite its potential, the metaverse also presents significant challenges, such as the risk of social isolation, the psychological impact of prolonged immersion in virtual environments, and the need for security policies to protect students from abuse and inappropriate content. It is essential for future implementations of the metaverse in education to be carefully designed to ensure a safe and inclusive environment.

5.3 Artificial Intelligence and Personalized Learning

Artificial intelligence (AI) is becoming a fundamental component of educational video games, enabling the personalization of learning experiences based on individual students' needs. AI systems can analyze student performance and adapt difficulty levels, content, and feedback in real-time to optimize the learning process (Shute & Zapata-Rivera, 2012). For instance, an AI-based educational game could detect if a student is struggling with a specific concept and provide additional explanations or practical exercises until the student achieves adequate understanding.

Personalization through AI helps overcome some limitations of traditional teaching methods by offering more direct and targeted support, fostering self-directed learning. AI can also facilitate monitoring student progress, providing teachers with valuable insights into each student's strengths and weaknesses and suggesting specific interventions to support their growth (Corno, 2008).

Another application of AI in education involves intelligent tutoring systems, which simulate the role of a human teacher and guide students through the learning process. These systems are particularly effective at improving problem-solving skills and strengthening students' intrinsic motivation, as they make learning an interactive and personalized process. However, implementing AI in schools raises ethical issues, including protecting personal data and ensuring equitable access to advanced technologies (Williamson, 2017).

5.4 Advanced Gamification and Challenge-Based Learning

Gamification involves using game elements in non-gaming contexts to increase engagement and motivation. While gamification has already been applied in many educational settings, its future involves evolving toward more advanced techniques and adaptive challenges. By employing advanced gamification techniques, such as personalized rewards, dynamic difficulty levels, and progress tracking, educational video games can create stimulating and interactive learning experiences that encourage students to surpass themselves.

For example, future educational games could use sophisticated reward systems to recognize not only academic achievements but also continuous improvement and perseverance, fostering personal growth alongside the acquisition of specific concepts (Kim, 2015). Advanced gamification could also integrate biometric monitoring sys-

tems, such as facial recognition or heart rate monitoring, to adjust the intensity and complexity of the game in real-time, keeping players in an optimal state of engagement and focus.

This challenge-based learning approach can contribute to developing transversal skills such as resilience, stress management, and the ability to work under pressure, which are crucial for academic and professional success. However, the use of advanced gamification also requires careful design and monitoring, as excessive reliance on gamification techniques can lead to dependency on external rewards, reducing students' intrinsic motivation (Ryan & Deci, 2020).

6. Conclusions

Video games represent a significant opportunity to enhance educational processes, making learning an engaging and immersive experience. With continuous technological progress, the role of video games in education is expected to grow, contributing to the creation of more inclusive learning environments.

Edugames, or educational games, represent a fusion of entertainment and learning, designed to improve cognitive, social, and technical skills. Games like *Minecraft: Education Edition* have been integrated into schools to develop problem-solving and collaboration skills (Bos et al., 2014).

Recent studies suggest that students who use edugames in school settings demonstrate a greater inclination toward active learning compared to those who follow traditional methods (Annetta et al., 2009).

The integration of videogames and emerging technologies into education represents one of the most promising frontiers for transforming how students learn. Technologies such as VR, AR, the metaverse, and artificial intelligence offer extraordinary opportunities to create personalized, immersive, and collaborative educational experiences. Additionally, advanced gamification can enhance motivation and foster the development of essential transversal skills for the future.

However, the success of these innovations depends on the ability to address challenges related to costs, accessibility, teacher training, and data security. Effective implementation requires targeted investments, forward-thinking educational policies, and collaboration between the public and private sectors.

Finally, it is essential to maintain a balance between technology and humanity, ensuring that learning does not lose sight of its fundamental purpose: to stimulate curiosity, promote critical thinking, and prepare students to live and contribute to a constantly evolving world.

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