Empowering Digital Storytelling: Fostering Environmental Awareness and Inspiring Sustainable Action Across Cultures and Generations

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Abstract. Nowadays, European education faces challenges like declining STEM interest, digital transformation needs, and climate change urgency. In response, the BIG GAME project integrates digital storytelling and game-based learning to foster STEM interest, enhance digital literacy, and address environmental issues through collaborative, scenario-based learning among secondary school students. This article introduces the project's innovative approach.

Keywords: STEM Education, Digital Transformation, Game-based Learning, Environmental Sustainability, Collaborative Learning.

1 Introduction

In today's European educational landscape, several challenges demand urgent attention and innovative solutions. Declining interest in STEM subjects (Bacovic et al., 2022), the need for digital transformation (Zeverte-Rivza et al., 2023), and the imperative of combating climate change stand out as key priorities (Mačiulytė-Šniukienė & Sekhniashvili, 2021). In particular, there has been a concerning decline in student interest and proficiency in STEM subjects. Despite the critical role of STEM education in fostering innovation and economic growth, this downward trend poses significant challenges for the future workforce and societal advancement (Chaminade & Lundvall, 2019).

Simultaneously, the digital revolution continues to reshape the landscape of education, requiring educators to adapt and leverage digital tools and methodologies effectively (Giang et al., 2021). As technology becomes increasingly ubiquitous, there is a growing need to support digital transformation in education to enhance the learning experience and prepare students for a digitally driven world (Vukšić et al., 2018).

Moreover, environmental sustainability and climate action have emerged as defining challenges of our time. With climate change threatening ecosystems and livelihoods

worldwide, there is an urgent need to educate future generations about environmental stewardship and inspire action to mitigate its impacts (Stevenson et al., 2017).

In response to these pressing needs, the BIG GAME project, Immersive and Multidisciplinary STEM Learning through A Cooperative Story-Driven Digital Game, cofunded by the European Commission through the Finnish National Agency in Erasmus Plus Programme – School Education (Code 2021-1-FI01-KA220-SCH-000024098), offers an innovative approach that integrates digital storytelling and game-based learning to promote interest and excellence in STEM education.

By combining the emotive power of storytelling with the interactive engagement of digital games, the project creates dynamic and immersive learning environments that resonate with students' interests and learning preferences.

Thus, by promoting excellence in STEM subjects, digital transformation and the fight against climate change, the project aims to forge a generation of citizens who are aware, competent, and actively engaged in building a better future. In this context, the article explores the educational methodology and approach lying behind the project.

2 Project Methodology

The primary objective of the BIG GAME competition is to foster creativity, problem-solving, and collaboration among secondary school students (aged 11-16) in Finland, Estonia, Italy, and Romania. Through this initiative, participants engaged in a stimulating learning experience that combines STEM (Science, Technology, Engineering, and Mathematics) concepts with digital storytelling and game-based learning. This approach not only enriched their educational journey but also equipe them with essential skills for the future.

To achieve this objective effectively, the competition presented students with real-world challenges centered around environmental and climate change issues. These challenges served as the backbone of the competition, encouraging participants to apply their knowledge and think critically about pressing global concerns. By addressing these challenges, students not only deepened their understanding of STEM concepts but also developed innovative solutions to complex problems.

By integrating elements of digital storytelling and game-based learning, the BIG GAME competition provided a dynamic and engaging platform for student participation. This multifaceted approach enhanced student motivation and comprehension, making learning both enjoyable and impactful.

At the same time, recognizing the crucial role of educators in guiding students through the competition, secondary school teachers were actively involved in the process. They served as mentors, facilitators, and motivators, helping students navigate through challenges and explore STEM concepts with confidence.

Students were organized into teams, where they pooled their knowledge and skills to tackle the competition challenges collectively. Organized in this way, the collaborative approach not only promoted teamwork but also cultivated a sense of camaraderie and shared purpose among participants.

At the conclusion of the competition, student projects were assessed based on criteria such as creativity, scientific accuracy, and effective communication. This assessment and recognition process served to motivate and inspire students, encouraging continued participation and growth within the STEM field. In the following paragraphs, authors briefly outline two basic approaches used in the project delivery, i.e. gamification and hybrid learning model.

3 Gamification in Learning Performance

Gamification, as educational strategy, is known to leverage the learning process by infusing it with elements of playfulness (Llorens-Largo et al., 2016). Unlike traditional methods, gamified courses offer students greater autonomy over their learning journey (Khaleel et al., 2016). They can select from various paths to demonstrate their knowledge, opting for assignments that resonate with their interests and strengths, such as papers, projects, or digital artifacts.

Embracing the concept of "safe failure," gamification provides low-stakes opportunities for learners to refine their skills through quizzes, peer activities, and multiple attempts at assessments (Zainuddin et al., 2019). Instead of penalizing mistakes, the approach focuses on "levelling up," rewarding students with points as they progress and achieve milestones. Research indicates that gamification not only boosts performance on practical tasks but also enhances learning motivation, fosters attitude and behavior changes, promotes collaboration, and heightens learner engagement (Roosta et al., 2016).

In addition, empirical evidence indicates that students immersed in gamified instructional paradigms exhibit superior learning outcomes, characterized by heightened levels of engagement and motivation (Huang et al., 2020). Finally, scholarly investigations consistently underscore the positive correlation between gamified learning environments and enhanced student performance (Imran, 2019).

4 Hybrid Learning Model

The Hybrid Learning Model integrates face-to-face instruction with online components, offering increased flexibility, access to diverse resources, personalized learning experiences, and support for various learning styles (O'Byrne & Pytash, 2015). Students can access content and activities both in-person and online, accommodating different schedules and preferences. By incorporating digital storytelling, game-based learning, and STEM curricula, hybrid models provide a rich array of multimedia resources. This approach allows for personalized learning experiences, where students can choose their preferred mode of learning, fostering engagement and understanding (Zou et al., 2021). Furthermore, the combination of narrative elements, interactive challenges, and analytical problem-solving caters to diverse learning styles, resonating with individual strengths and preferences. Research suggests that hybrid learning methods enhance student motivation, engagement, and learning outcomes, bridging theory with practical application in education (Cheung & Ng, 2021).

In addition, research indicates that storytelling can significantly enhance STEM education, particularly in engaging students and promoting deeper understanding (Jantakoon et al., 2019; Wang & Shao, 2016). Utilizing narratives not only aids in conveying information effectively but also stimulates various parts of the brain, leading to enhanced retention and comprehension. For instance, studies have shown that storytelling activates sensory and motor areas of the brain, fostering a more immersive learning experience compared to conventional teaching methods (Fernando & Marikar, 2017; Wang & Zhan, 2010).

Furthermore, incorporating digital storytelling allows students to create and share their own narratives, thereby fostering essential skills such as research, writing, organization, technology proficiency, and teamwork (Frydenberg & Andone, 2016). By designing and presenting their stories, students develop critical thinking, problem-solving, and communication skills, transcending traditional academic boundaries.

Narratives provide a powerful tool for contextualizing STEM concepts, enabling students to connect with the subject matter on a deeper level (Frydenberg & Andone, 2016). For example, exploring real-life stories like Henrietta Lacks' immortal cells not only teaches biology but also raises ethical and social issues, encouraging critical analysis and empathy among students (Hunt et al., 2020).

In mathematics education, digital storytelling offers opportunities for exploring complex concepts through visual media, such as analysing Escher's artwork (Triantafyllou & Timcenko, 2014) or examining socio-economic themes in literature like "Behind the Beautiful Forevers" (Pyper, 2017).

Ultimately, storytelling in STEM education not only enhances academic learning but also cultivates a range of essential life skills beyond the classroom curriculum, empowering students to become proficient problem solvers, effective communicators, and lifelong learners (Bertrand & Namukasa, 2020; Parno et al., 2020).

In the BIG GAME project, the consortium has applied the potentialities of the digital storytelling to the environmental issues by challenging secondary school students from Europe to solve green missions.

5 Digital Game and Students' Activity

In the BIG GAME project, the research activities in classrooms aimed to engage students in addressing environmental challenges through a scenario-based learning approach. Students worked in groups to research local environmental issues and proposed solutions within the context of a futuristic scenario set in 2030.

The scenario setting was referred to the Earth, which is facing worsened climate challenges in 2030, prompting the formation of the UN Anti-Apocalypse Force who challenge the students to find solutions to specific urgent environment issues through the digital game.

Fig. 1. The Digital Game to challenge the students to solve environmental missions through digital stories.

The EU teams' students focused on local environmental issues, research solutions, and submitted their findings through the digital game. All the scenarios submitted were part of the BIG GAME competition where the Game Project Team evaluated scenarios based on feasibility (e.g. Could the solution realistically be done in practice), effectiveness (Would the solution solve the problem?), practicality (Does it make good use of our limited resources?), and clarity (Is the solution understandable and well-presented?).

The goal was to empower the students involved of globally conscious citizens equipped with the knowledge, skills, and passion to create positive change. By leveraging the engaging BIG GAME learning model, immersive experiences through the environmental missions to solve, and game environment, students could cultivate advanced digital literacy and be inspired by tangible actions to safeguard the planet.

Through this process, students not only learned about environmental issues but also develop critical thinking, research, and presentation skills while actively contributing to finding solutions for real-world challenges.

A total of 121 teams from 27 schools in four countries took part in the competition.

Throughout the competition, the teams submitted 270 mission solutions in total. Winning teams were determined based on points accumulated and missions won. The top three teams are Hazel Tarantulas (FI), Green Elephants (RO), and Black Bobcats (RO). Winners receive a Winners' Badge in the game environment. Additionally, teams like Black Storks (RO), Teal Salamanders (IT), Yellow Dolphins (RO), Cyan Finches (EE), White Ants (IT), Cyan Giraffes (FI), Silver Crabs (EE), Amber Hawks (IT), and Silver Hornets (FI) receive honourable mentions for consistent performance throughout the competition.

6 Conclusions

Central to this endeavor have been students and teachers who have served as protagonists in a holistic educational journey that has prioritized didactic innovation and individual responsibility to deal with environmental issues. In this context, the BIG GAME project has intended to bring innovation, particularly in the vital fields of science, technology, engineering, and mathematics (STEM). By promoting multidisciplinary learning and problem-solving within the green missions, students have been equipped with the critical skills needed for the digital age. Through the hybrid learning model, coupled with digital storytelling methodologies, BIG GAME has intended to support the transformation of educational practices, ensuring that both teachers and students alike are adept in navigating digital environments. The next step will be to introduce and text this methodology at another level of study, such as in primary schools.

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