THE BIG GAME: Immersive and Multidisciplinary STEM Learning through A Cooperative Story-Driven Digital Game

Code 2021-1-FI01-KA220-SCH-000024098

R1. The BIG GAME Learning Concept and Model

Final Report

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Contents

Contents

INTRODUCTION

The Game Team project designed and developed the Game environment based on the R1.1 game world and environmental issues, in which 251, 11-16-year-old students and 62 teachers from Finland, Italy, Romania, and Estonia were engaged.

Besides the technical issues, the project team, in accordance with the game team, identified the teaching and learning process to be implemented in and outside the classroom. A template has been designed to build the learning scenarios/game missions, which will support teachers and students in engaging in the BIG GAME activities and competitions during and beyond the project's end.

With this template, the project partners constructed the first learning scenarios (n. 23) collected in the R2 Handbook and Toolkit on the Digital Storytelling approach in STEM. Afterwards, the project partners prepared n. 8 learning scenarios to guide the teachers and students in implementing the BIG GAME approach in and outside the classroom by creating multidisciplinary scenarios.

In this report, we describe the procedures for implementing activities both inside and outside the classroom, with and without the BIG GAME Environment.

1. HOW TO APPLY THE BIG GAME APPROACH IN THE CLASSROOM

To implement the BIG GAME approach in the classroom, teachers will be facilitated to follow these steps:

1. **Introduction to Environmental Issues:** Teachers will provide students with information on environmental challenges. They can choose the topic, or the students will be able to suggest their own choice.
2. **Setting the Learning Scenario:** During the BIG GAME competition, all the learning scenarios were set in 2030. We can imagine that the Earth is facing big climate challenges. To promote the student's engagement in and outside the Game Environment, it has been imaged that The United Nations has established the UN Anti-Apocalypse Force (UNAAF), wherein student teams play pivotal roles in addressing global environmental emergencies.
3. **Preparation and Topic Delivery:** Optionally, teachers may prepare the topic for study, exemplified by Operation "Black Ice" (see **Annex 1**), to convey specific themes effectively. However, more missions are available in the Digital Bank or in the Game Environment.
4. **Activity Management:** a good practice to let students (aged 11-16) collaborate in groups of 3-4 members. In this way, the teachers have the flexibility to manage classes effectively.

Students, in turn, will undertake the following tasks:

1. **Research:** Students will research selected environmental issues, focusing on local and specific challenges that may be relevant to their region.
2. **Scenario Development:** Students will develop the scenario idea, identifying the problem to be addressed and its setting.
3. **Information Gathering:** Students will gather information about the selected environmental problem and propose potential solutions.
4. **Scenario Preparation:** Using a provided model (Figure 1), students will analyse the problem and prepare their scenarios accordingly.

Students will immerse themselves in real-world environmental challenges by engaging in these collaborative and research-oriented activities, fostering critical thinking and problem-solving skills within the BIG GAME framework.

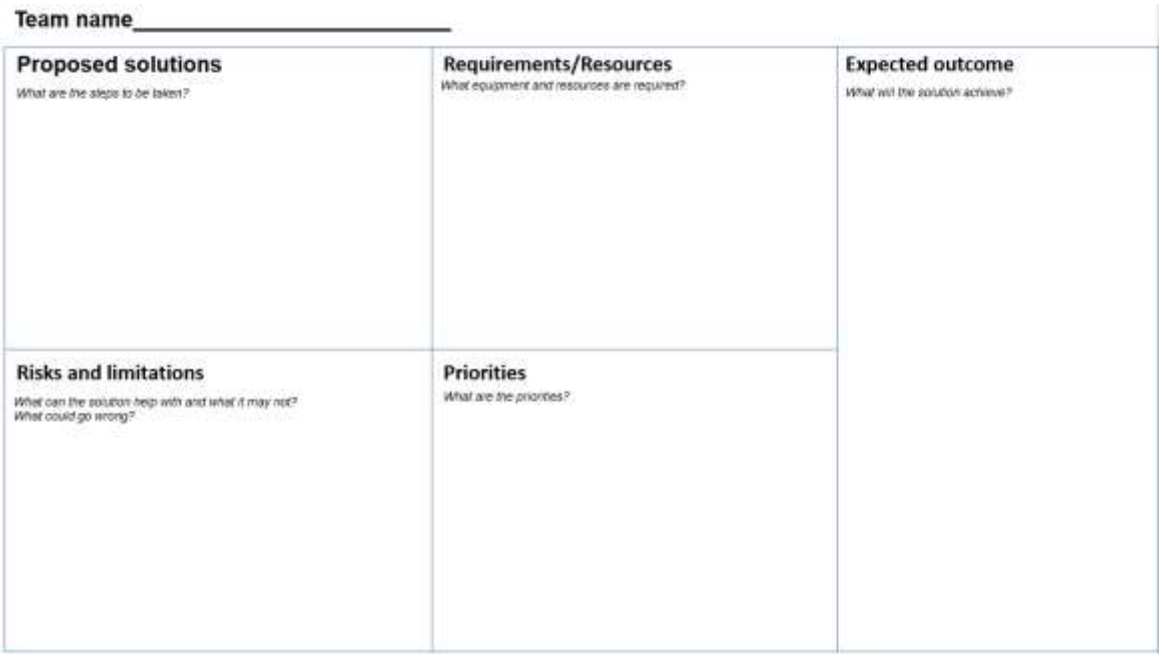

Figure 1 – Model for students' research.

During students' work, teachers should actively observe, assist, and motivate students as they develop their scenarios, ensuring they remain focused and offering support as required.

Additionally, teachers should assist in sourcing suitable references for scenarios and ensure compliance with copyright regulations for any external materials used.

Furthermore, they should manage and oversee classroom groups, nurturing productive collaboration and sustaining an optimal learning atmosphere.

During their research work presentations, students should prepare multimedia-enriched presentations, employing a variety of visual aids such as images, videos, and relevant materials to present their findings to their peers and instructors.

To help the teachers and the students, the project team prepared a Scenario Presentation Template (**Annex 2**) to structure their presentations, focusing on:

- the problem description,
- problem solution (What are the steps to be taken?),
- expected outcome (What does the solution aim to achieve?),
- requirements (What kinds of equipment and resources are required?),
- risks and limitations (What can the solution help with and not?, What could go wrong?),
- links to resources used.

ATTENTION: students should be strict with copyright regulations, ensuring proper attribution and seeking necessary permissions for all external references incorporated into their presentations, fostering a culture of academic integrity and ethical research practices within the classroom setting.

Following these steps, teachers and students can effectively integrate the BIG GAME approach into the classroom, fostering engagement, creativity, and critical thinking skills while addressing real-world environmental challenges.

1.1 Assessing Student-Developed Learning Scenarios within the BIG GAME Approach

In the evaluation process within the classroom using the BIG GAME approach, the initial step involves assessing the digital products created by students to describe their scenarios regarding environmental challenges and their findings.
This evaluation occurs within the class in front of the class or on school premises with the involvement of other classes or the invitation of environmental experts or teachers/students from other schools.
To make the evaluation procedure effective, a peer-review mechanism has been selected.
Peer review in the classroom holds significant potential for enhancing learning outcomes within the BIG GAME approach. By involving students in the evaluation process, peer review promotes a collaborative learning environment where students receive feedback from their peers and actively engage in providing constructive criticism and insights to their classmates. This process fosters a deeper understanding of the subject matter as students critically assess and reflect on each other's work.
The aim is to encourage communication skills, teamwork, and empathy as students learn to consider diverse perspectives and offer supportive feedback.
In the BIG GAME Approach, the peer review is guided by three to four questions formulated by the teachers specifically for their students. These questions prompt the teachers to assess the learning scenarios' depth, coherence, and effectiveness.
To help the teachers, in this phase, the project team suggests a rubric, as shown in the Table below, to provide structured assessment criteria for evaluating the students' scenarios designed in the classroom.

Table 1. Rubric for the student's learning scenarios designed in the classroom.

CRITERIA	LEVELS		
	YES	NO	TO BE IMPROVED
Learning scenario guides to waste less natural resources.			
Learning scenario suggests products that have a low environmental impact.			
Learning scenario suggests processes that have a low environmental impact.			
Learning scenario suggests an organisation that has a low environmental impact.			
Learning scenario suggests sustainable solutions.			

This rubric ensures consistency and fairness in the evaluation process, facilitating meaningful feedback to enhance further students' understanding and proficiency in addressing environmental challenges within the BIG GAME framework.

2. THE GAME ENVIRONMENT IN THE BIG GAME APPROACH

It is possible to access the Game through the project website (https://big-game.eu-track.eu/) from the "Results" section – R1 The BIG GAME Learning Concept and Model" as shown in the Figure below.

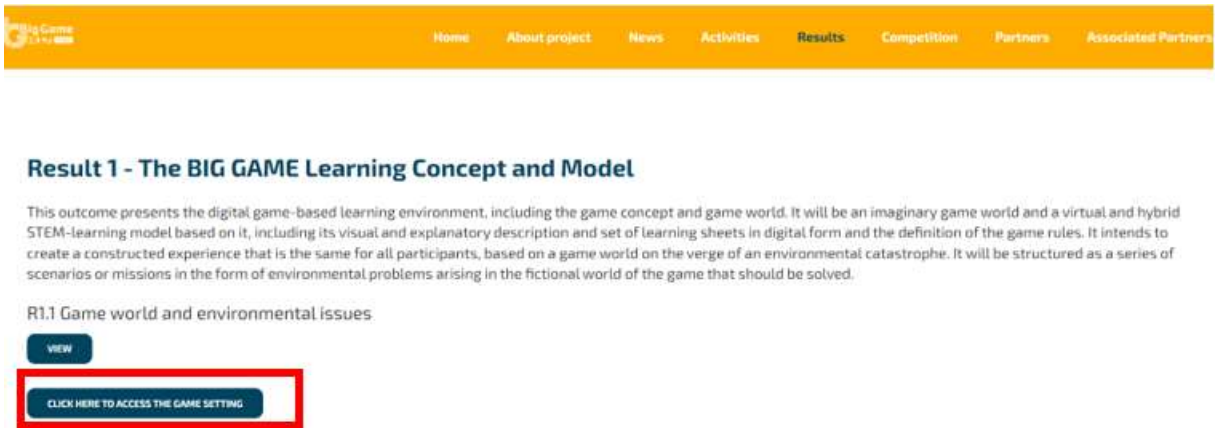

Figure 2 – Access the Game Environment through the project website

The Game environment can be accessed during the project implementation by a team login, password, and user ID provided after the team's registration with the form available on the website, as shown in the Figure below.

Figure 3 – Access the Game Environment during the BIG GAME implementation.

Once the team was inside the Game, they could see the “mission data” and the “team information” (Figure 3).
The mission data displayed all the information regarding the mission to be solved, such as the title, the status (for example, submitted), and the evaluation schedule.
In the team information, the team could see the team’s name, the country of residence, the number of missions completed and the results of the missions’ evaluation of the team.

Figure 4 – Inside the Game Environment

In addition, there are three buttons: *briefing*, which shows the mission briefing as a dialogue with the game characters (Figure 4); *report*, which shows a text-based report (Google Doc) containing mission information, like the **Annex 1**; *submit*, which takes each team to their empty mission solution template (**Annex 2**) to submit their solution to the Evaluation Committee.

Figure 5 – The two pictures show part of the dialogue with the game characters to summarise the game mission.

2.1 *The evaluation process inside the Game*

A special evaluation committee evaluated all submissions, constituted of partner staff and experts in STEM education, environmental issues, and game design.
The evaluation criteria were the following:

- **Efficacy**: how effective is the proposed solution at dealing with the problem (i.*e., would following the proposed steps make the problem disappear or at least minimise its negative effects?*).
- **Pragmatism**: how realistic the solution is considering available technology and limited resources (*i.e., not requiring thousands of workers to implement and not relying on futuristic technology that hasn't been invented yet*).
- **Scholarship**: how well did the team do their research (*as evidenced by how well they understand and use key terms, how relevant the sources listed on the final slide are, etc.*).
- **Persuasion**: how well the solution is presented (*clear wording, good use of images, etc.*).

Committee members evaluated each submission, grading each of the criteria above on a 1-5 scale (1 = poor; 3 = average; 5 = outstanding) as specified in the following Table and the **Annex 3 – Evaluation grid**.
Based on this, teams were awarded +1 stars in one or more categories: teams with a higher average score will earn more points than those with a lower score; however, every team earned at least one star.
Teams with the highest average score that also submitted the most sensible type of solution were declared mission winners.

Table 2. Evaluation Grid used for the missions submitted in the Game.

Criteria	1 STAR	2 STARS	3 STARS	4 STARS	5 STARS
EFFICACY: would the proposed solution solve the problem?					
PRAGMATISM: how practical, efficient, and doable is the solution?					
SCHOLARSHIP: does the solution cite multiple relevant and reliable sources?					
PERSUASION: is the solution clearly explained and presented well?					

At the end of the BIG GAME competition, 121 student teams representing 27 schools across four countries participated: Romania (24 teams), Italy (6 teams), Estonia (19 teams), and Finland (72 teams). Collectively, these teams submitted 270 mission solutions throughout the competition.

The Evaluation Committee recognised the teams that showed a consistent performance and gained high star accumulation throughout the Game, such as the teams 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).

The award ceremony was held in the respective country, as shown in the Figures below, by delivering the certificate and badges designed for the BIG GAME competition to the students.

Figure 6 – The badge and the certificate delivered to the students' winner teams.

Figure 7 – The badge and the certificate delivered to the participants.

3. THE SUSTAINABILITY OF THE GAME ENVIRONMENT BEYOND THE BIG GAME PROJECT

The game environment will remain accessible for at least five years after the project's conclusion. The game files will be hosted on Tallinn University servers, while the project website will remain the main point of access to the game.

Considering that both participating schools and external partners who the project was introduced to expressed an interest in continuing to use the game environment, the content of the game has been made publicly accessible and no longer requires logging in (as was the case during the competition). At the same time, team login functionality has been disabled, as following the end of the competition, it serves no purpose.

Figure 8 – The updated starting screen

In addition to the three missions used in the competition, the final version of the game environment contains seven more environmentally themed missions, three of which are based on ideas suggested by school teams. As before, these consist of a short briefing session involving the non-player characters, as well as a text-based mission report. These missions are accessible through the Mission Information screen, which replaces the Team Information screen used during the competition.

The environment in its updated version can be used by educators in different settings and different ways (e.g., as a classroom activity or project-based home assignment). The selection of 10 missions covers different environmental issues, allowing educators to pick the missions that are relevant to their learning objectives and play the missions in any order.

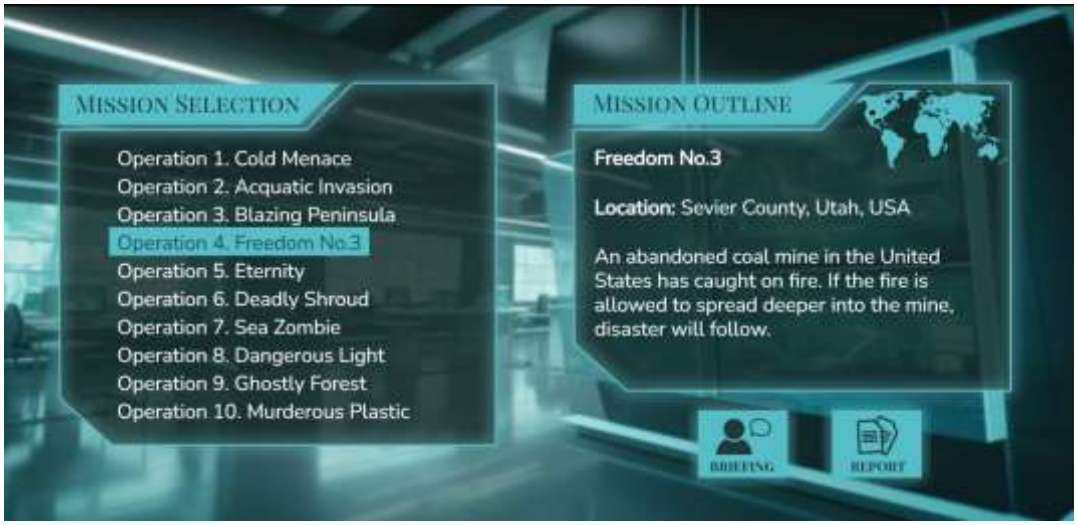

Figure 9 – Mission Selection screen

The updated game environment will be periodically monitored for technical issues (at least once every 6 months), and users can report issues they encounter using the project email address, which will also remain available.

The project results will be further disseminated through academic presentations and a research article, helping recruit more potential users for the game environment.

4. CONCLUSIONS

This report has comprehensively outlined the procedures and methodologies for implementing the BIG GAME approach within classroom settings and via the digital Game Environment. Key highlights and future implications include:

- Classroom implementation: The BIG GAME approach has been successfully integrated into classroom activities, promoting a structured framework for engaging students with environmental issues through digital storytelling and scenario-based learning. The approach allows for a dynamic learning environment where students can explore real-world challenges while developing essential skills such as critical thinking, collaboration, and problem-solving.
- Digital Game Environment utilisation: The digital Game Environment acts as a critical tool for extending learning beyond the physical classroom, offering an interactive platform for students to apply their knowledge in simulated real-world scenarios. This setup not only enhances engagement but also allows for a practical understanding of complex environmental issues.
- Sustainability and future applications: The project's sustainability beyond its current framework is promising. The digital assets and pedagogical strategies developed can be adapted for ongoing and future educational purposes, potentially influencing a broader curriculum that spans beyond the participating schools and regions.
- Assessment and evaluation: Both peer-reviewed classroom evaluations and structured digital assessments within the Game Environment have shown effectiveness in measuring and enhancing student understanding and engagement. The established evaluation criteria and processes ensure consistency and provide valuable feedback for continuous improvement.
- Expansion and scalability: The potential for scaling the BIG GAME approach to include more diverse environmental issues and incorporate a wider range of academic disciplines is significant. This scalability can lead to a more integrated and comprehensive educational model that addresses various global challenges through interdisciplinary learning.

Moving forward, it is recommended that future iterations of the BIG GAME project continue to enhance the Game Environment with updated content and technology to keep pace with educational needs and environmental developments. Moreover, extending the project’s reach through additional partnerships will further its impact, making environmental education more accessible and engaging for students worldwide.

By maintaining the momentum gained from this project and continuously evolving the educational tools and approaches, the BIG GAME initiative can serve as a pivotal model for integrating environmental education into school curriculums around Europe.

ANNEX 1 – An example: Operation “Black Ice”

Mission statement

On March 3rd, 2030 (Sun) at 3:30 am, a research vessel (The Vassa, flying a Swedish flag) and an oil tanker (The MT Dolviken, flying a Norwegian flag) collided near the Norwegian island of Andøya in the Arctic circle. Due to the impact, the oil tanker’s hull was pierced, resulting in an oil spill into the sea. By following the Shipboard Oil Pollution Emergency Plan, MT Dolviken crew were able to locate the damaged tank and stop the spill within an hour; however, by that point, a significant quantity of oil was spilt into the sea. Both ships’ crews were then evacuated by air rescue.

The situation is time-sensitive due to the oil leak in a natural reserve less than 4 km from the Bleiksøya cliff, home to one of the largest surviving sea puffin colonies. The fishing village of Bleik, a popular bird-watching destination, is also nearby.

The UN Anti-Apocalypse Force (UNAAF) has been activated to address this threat. You can be on site by 6 am local time. What is your course of action?

Location and environmental conditions

5 km off the coast of Andøya island in the Arctic Circle, part of Norway’s Skogvoll natural reserve. The closest settlement is the fishing village of Bleik (population 500), and the sea puffin colony on the Bleiksøya cliff is 4 km away. It is possible to airlift to the site from Harstad in 20 minutes.

Due to the icy waters, navigation is difficult, and since the ice is breaking, the spill can spread fast and reach both the cliff and the nearby village of Bleik, affecting local fisheries and tourists.

ANNEX 2 – Scenario Presentation Template


Links to resources


Thank you for attention!

ANNEX 3 – Evaluation Grid

Team name: _____

Country: _____

CRITERIA	1 STAR	2 STARS	3 STARS	4 STARS	5 STARS
EFFICACY: would the proposed solution solve the problem?					
PRAGMATISM: how practical, efficient, and doable is the solution?					
SCHOLARSHIP: does the solution cite multiple relevant and reliable sources?					
PERSUASION: is the solution clearly explained and presented well?					

Please provide a general comment for your decision:

_____

_____