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

R1.1 Game world and environmental issues

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Elaborated by	Tallinn University (EE) EU-Track (IT) University of Turku (FI) in collaboration with : All partners
Activity related	**R1 The BIG GAME Learning Concept and Model**
Deliverable N° and title	R1/A1 Definition of the game concept, elements, and game world for the learning scenario. R1/A2 Analysis of the environmental problems/issues relevant to each partner country.

Contents

Introduction

This outcome is a part of *R1 The BIG GAME Learning Concept and Model*, aiming to present the digital game-based learning environment, including the game concept and game world. In particular, it refers to tasks A1 and A2.

First, the project team will define the game concept, elements, and game world to be used in constructing the learning scenario. Second, each partner country will analyse the environmental/critical issues which each country should deal with. This will set the game environment following the main environmental needs and emergencies that emerged in the partner countries.

In order to develop more suitable project products, which can match the students' interests and needs, two surveys were administered: the first was aimed at learning about the mechanics and characteristics of games that are more engaging for 11–16-year-olds, and the second, sent to the teachers, was to investigate the environmental challenges faced by each country involved (Finland, Italy, Estonia and Romania).

This report will describe the results achieved by both the survey's tools.

1. An overview of the Students' game world

1.1 Students' profile

The online questionnaire was administered via a Google Form involving secondary school students from Finland, Italy, Estonia, Italy and Romania. It attracted so much interest that from the expected 100 students, the survey collected 251 replies, as shown in Figure 1. In particular, 69% were from Romania, 11% from Italy and Estonia, and 9% from Finland.

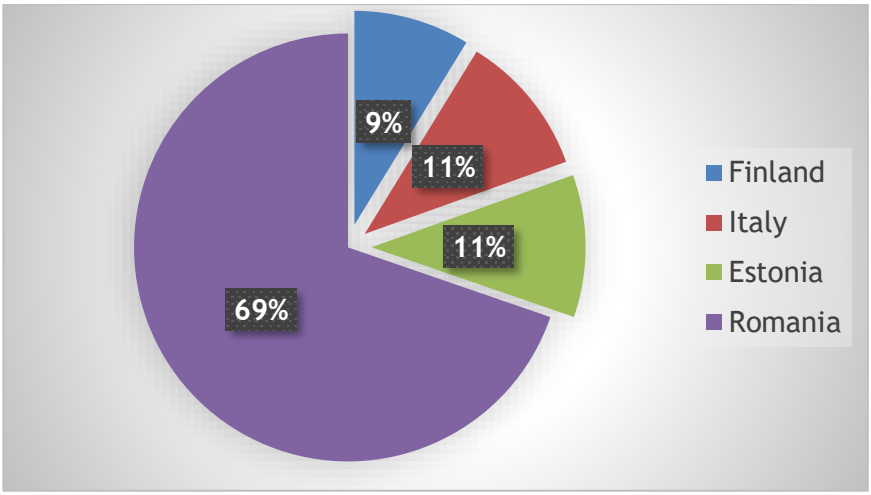


Figure 1 - Geographical distribution of the sample.

The target group is specifically secondary school students. In detail, the survey involved mostly 15-16 years old learners (45%), while 31% were aged 11-12 and 24% were aged 13-14 (Figure 2).

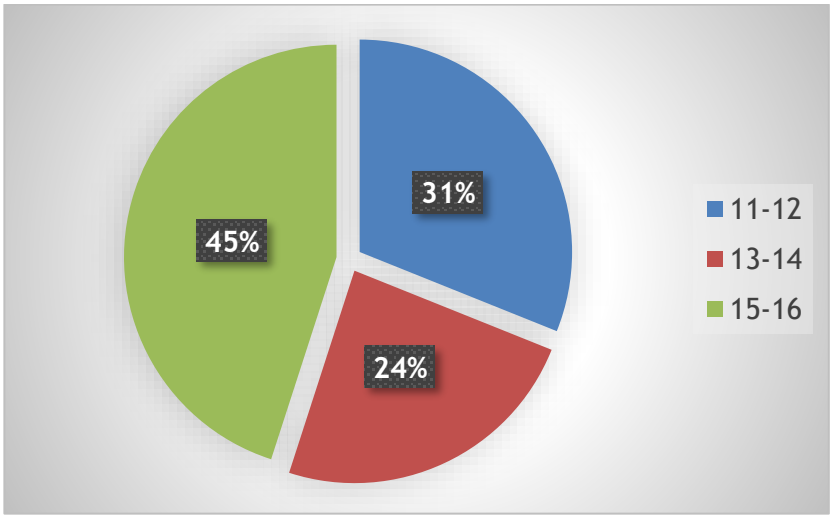


Figure 2 - Age distribution of the sample.

1.2 Students' preferences and habits in games

The second part of the questionnaire aimed to better understand the students' preferences in playing games. The scope was to collect all useful information to customise the game learning environment.

The students involved in the survey generally spent a lot of time playing games. In fact, 35% stated that they usually played for more than one hour, 57% played between 30 minutes and one hour, and only 8% for less than 30 minutes (Figure 3).

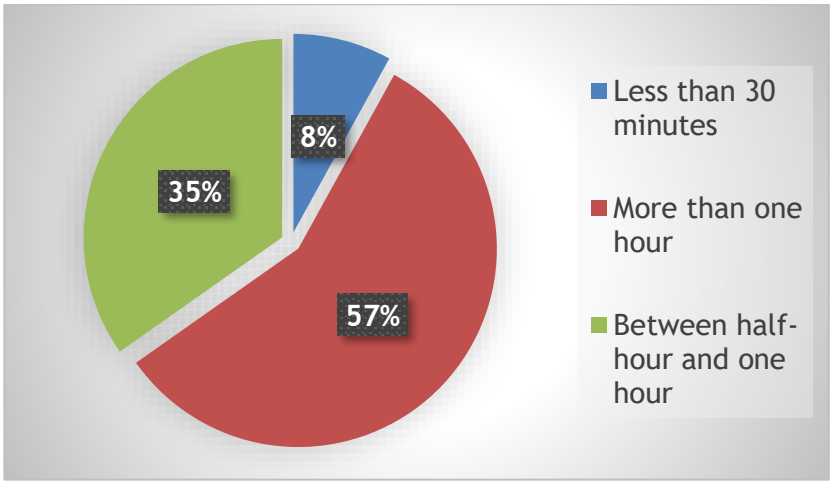


Figure 3 - Time spent every day playing video games.

The attractiveness for most students towards the games is to overcome challenges, get better at the game (51%), and compete against other players (49%), as shown in the next Figure. Therefore, the competition element and the capacity to overcome one's own limits are always the keys to keeping the students' interest high.

However, students sometimes want to experiment and discover new things (37,05%) and create and develop a character (25,90%). A game feature not considered very interesting in relation to the elements mentioned above is the possibility to socialise with the other players (10,36%).

The results underline that 10.76% of the sample "don't play games". Compared with the results previously described in Figure 3, this percentage probably refers to students who are not very fond of video games or don't spend much time playing them.

Figure 4 - What students enjoy about playing games (*).

(*) The percentage sum is not 100% because the students could select more than one item available.

Most 11-16 years-old students participating in the survey prefer a real world in the present day or in the past as a game setting (Figure 5), even if they don't mind a game environment scenario based on science fiction, such as near-future Earth (31,08%).

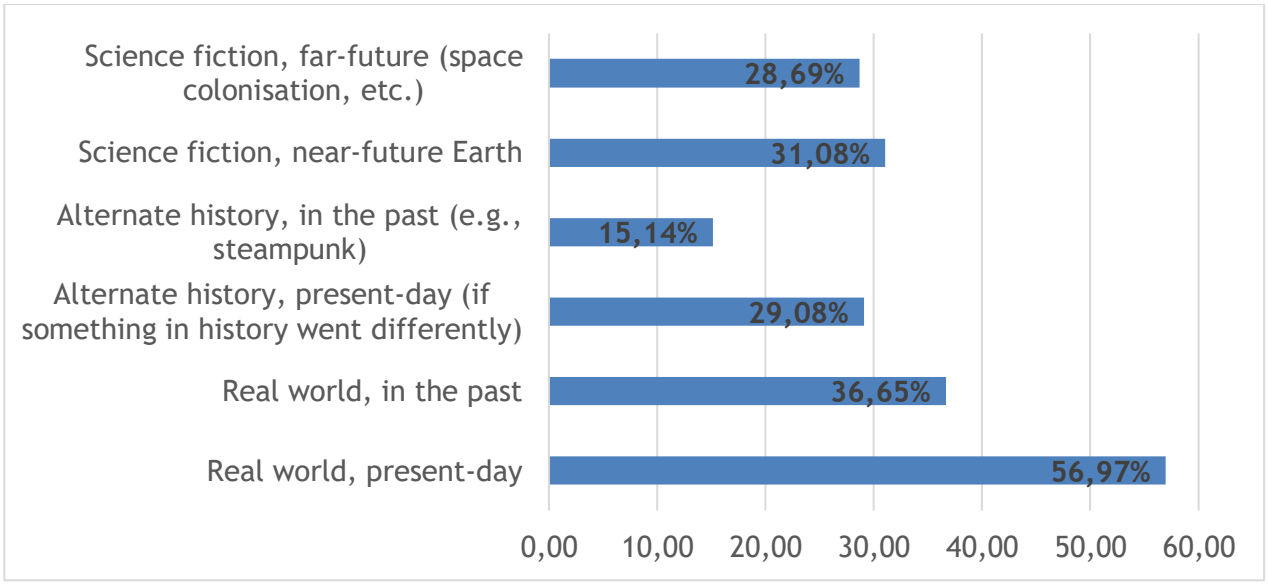


Figure 5 - The favourite location for the students to play a game.

Regarding the type of game, the students prefer “Action and FPS” (46,61%). FPS stands for First Person Shooter. This means that only hands are shown while gaming instead of a full character, so it is any game where the camera shows what your character is seeing.
In particular, the player experiences the action through the eyes of the protagonist. The genre shares common traits with other shooter games, making it fall under the heading of action games.

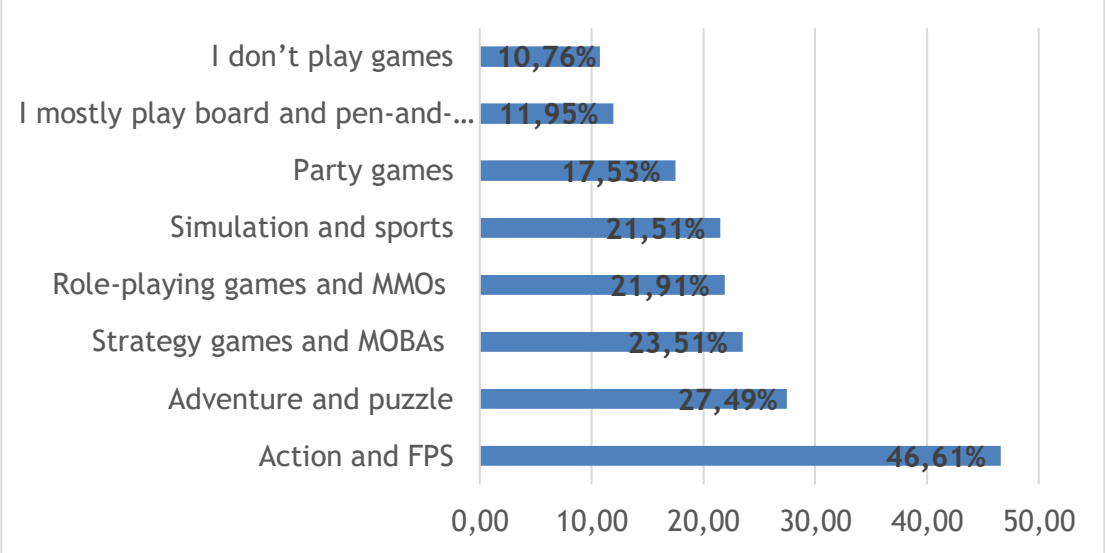


Figure 6 - The type of games played by students.

Students like playing a game with other players online (50%) more than with other friends situated in the same room (23%). Another option is to play “solo” games with a single player.

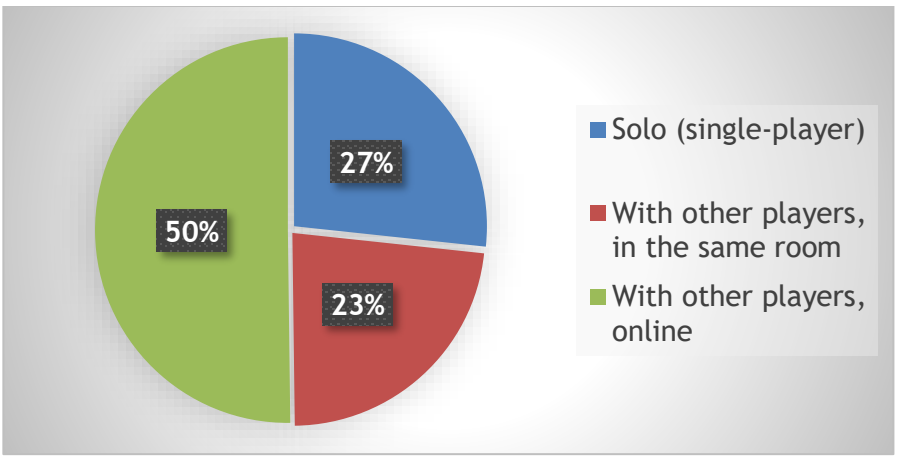


Figure 7 - Game modality.

The devices that the students usually use to play on, in most of cases (60,16%), are Smartphones or Tablets, but PCs or game consoles are also suitable for them.

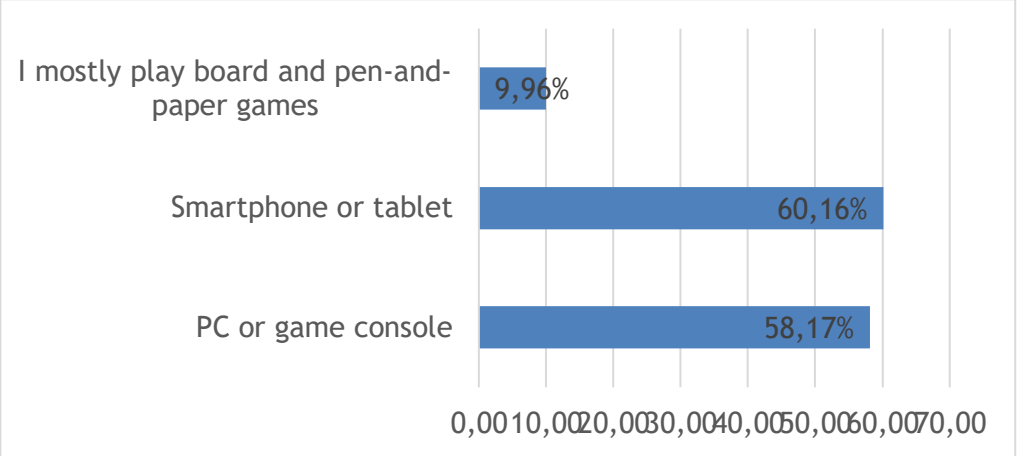


Figure 8 - The devices usually used by the students.

In games, rewards are most typically applied in the form of badges, prize items, leaderboards, and points. However, the ones preferred by students are points (38,65%) or Prize items (33,07%)

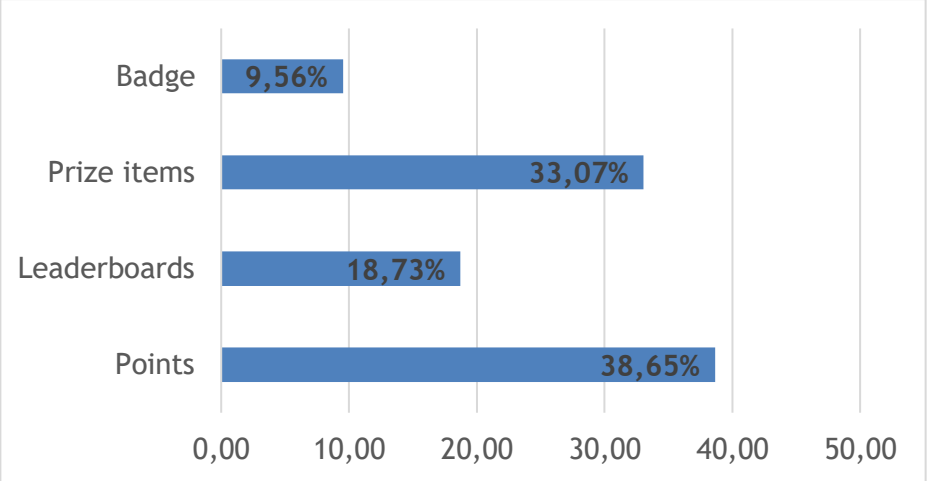


Figure 9 - Type of rewards preferred by the students.

1.3 Environmental issues and the students

Environmental issues such as global warming, air pollution and ozone depletion have become global challenges. However, environmental awareness, environmental concern, environmental attitude, and environmental behaviour of students are potential factors that may help in coping with these challenges. Therefore, the students' environmental awareness was investigated through this survey to understand what kind of missions or challenges can be constructed for the BIG GAME game-learning environment.

The results, as described in Figure 10, show that students are mainly aware of “Climate change” (29,69%), “Air pollution” (17,93%) and “Water pollution” (17,53%).

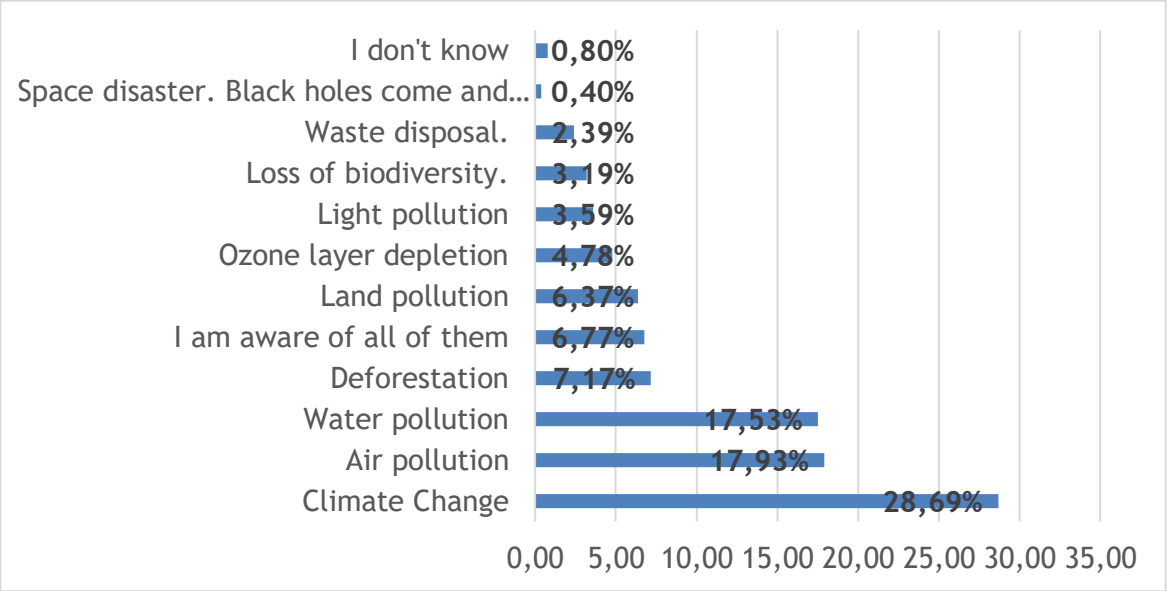
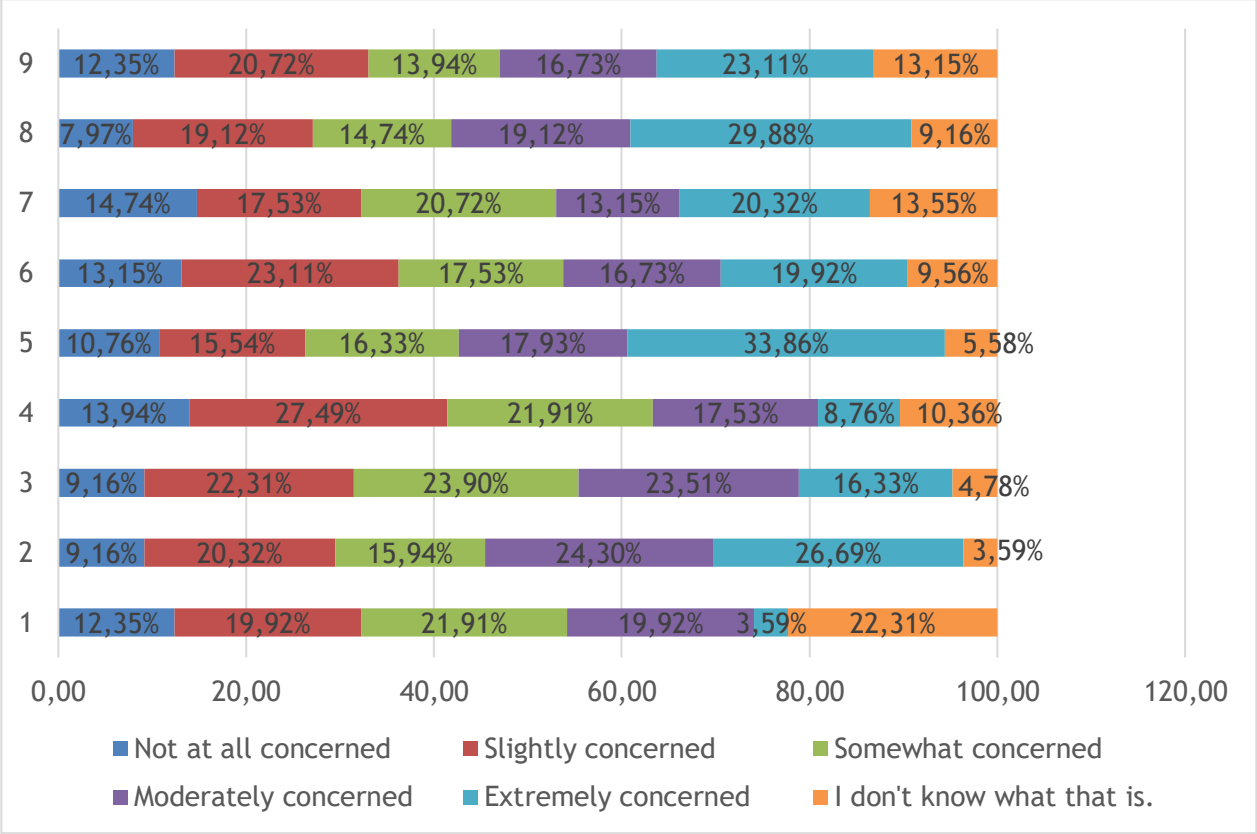


Figure 10 - The environmental issues that students are aware of.

However, what arouses their concerns are mainly, according to the data shown in Figure 11, “Climate change” (33,86% - Extremely concerned), “Deforestation” (29,88% - Extremely concerned) and “Air pollution” (26,69% - Extremely concerned).



1 - Water pollution
2 - Air pollution
3 - Land pollution
4 - Light pollution
5 - Climate change
6 - Waste disposal
7 - Loss of biodiversity
8 - Deforestation
9 - Ozone layer depletion

Figure 11 - Students' concerns about environmental issues.

2. Investigate environmental challenges faced by the partner country

In total, 62 teachers participated in the questionnaire. As shown in the diagram below, the majority of the teachers who participated are from Romania, with 25 participants, followed by Italy with 19 participants, Estonia and Finland with 10 and 5 respondents, respectively. It has to be noted that 59 out of 62 respondents answered the question.

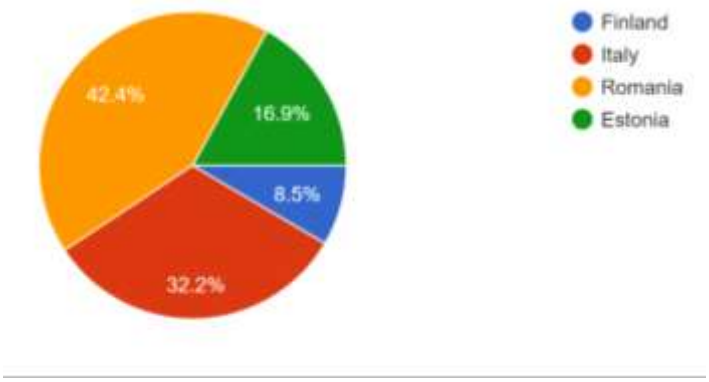


Figure 12. Respondents per country distribution.

Regarding an inquiry on the game objectives, a game for students should have the aim of "Developing skills and procedural knowledge" and "Encouraging behaviour/attitude change"; these objectives were checked by more than half of the respondents in each case. At the same time, considering a game as a means to increase interest in the subject or develop conceptual knowledge results in nearly one-third of the respondents cumulatively (see Figure 2).

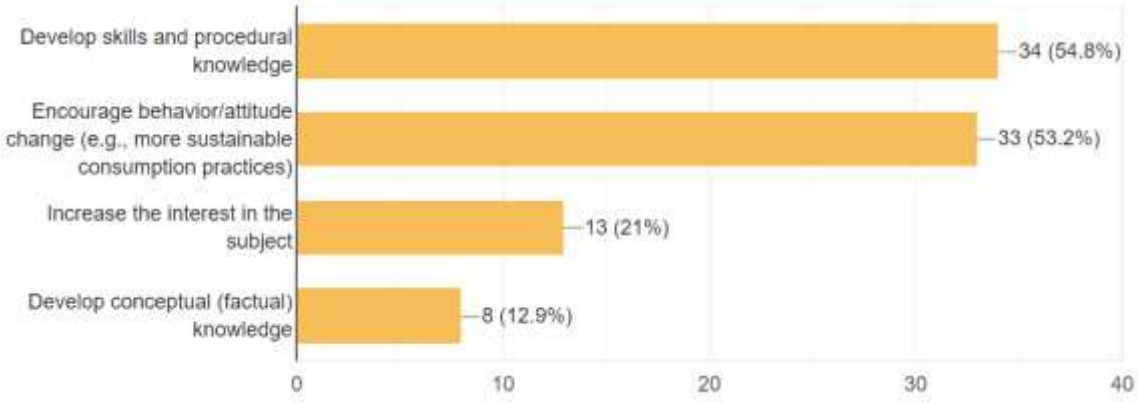


Figure 13. What objective/s should a game for students have?

Nevertheless, when a game is considered a helper in **conceptual knowledge development**, as viable argument, the following was noted:

- Global warming, sustainability, consumption, and other global concerns in general (e.g., common human identity and common destiny);
- Language, literature, history, geography, science, physics and chemistry in everyday life;
- Algorithms and strategy development;
- Social skills.

As one can see, the essence of the answers may be outlined by the response of a teacher from Romania, who rightfully underlined that: "*in theory, any subject - ranging from language and literature to STEM subjects and art - can be embedded in a game and became part of the game's plot*."

Instead, when a game is seen as an auxiliary tool for **developing skills and procedural knowledge**, the skills specified (apart from teamwork and problem-solving) are the following:

- Cooperation, negotiation, and communication skills;
- Critical and scientific thinking, scientific method and analysis, reasoning and argumentation;
- Hand-to-eye coordination, quick and correct answers to problems, synthesis and analysis;
- Leadership;
- Learning by doing;
- Listening;
- Applying problem-solving in new, cooperative learning contexts;
- Valid answer formulation;
- Climate change and our possible preventive measures;

Finally, when the game's main objective is perceived as encouragement of behaviour/attitude change, the basic underlying leitmotiv revealed is that teachers are generally aware that games have a certain impact on children's attention and therefore are capable of becoming a valuable instrument in the class. Teachers agree that games are capable of improving how students learn. In particular, according to the responses gathered, the game's possible objectives, in this case, were mainly related to environmental and social issues. Below examples of responses grouped into corresponding categories are provided.

Social attitudes:

- patience and respect for others;
- collaboration and cooperation;
- fair-play;
- boosting self-confidence and self-esteem;
- students should be helped to learn the "proper" way of behaving in class;
- developing the habit of listening to and accepting others' opinions, building tolerance, stimulating interest in global issues and encouraging involvement in bringing positive change;
- attitudes towards internet safety.

Environmental issues:

- selective trash-collecting;
- respect and care for greenery in one's city;
- opting for more sustainable and active ways of transportation -walking, cycling;
- sustainability and the carbon footprint of the internet;
- recycling, reusing, and reducing the consumption of energy, water, and plastic;
- acknowledging the consequences of customer choice when buying (unnecessary, fast-fashion clothing items);
- taking into account how green the product line is of everyday devices. Not only focussing on if you use the device in an environmentally friendly way or not, but also looking at how the device is produced.

The general core idea expressed could be summarised as follows: "*teaching through games could lead to children being more immersed in studying than during a regular class, students can gain knowledge, but they don't use what they already know, they still act as they don't care". Therefore, "the aim should be to get them to actually do something, even though it might be less convenient, e.g., preferring public transport/a bike over a car. Also, what kind of sustainable change pupils can perform in their everyday lives, what kind of co-operational changes they can perform in their society etc.*"

Thus, it can be concluded that a game as a flexible and complex media capable of delivering multifaceted cause-and-effect relationships may make students aware of their responsibility for every decision they make.

Environmental challenges outlined (first challenge):

- Deforestation, reclaiming green areas, uncovered landfills;
- Waste sorting, recycling and burning;
- Loss of biodiversity;
- Pollution, use of coal;
- Oil shale mining;
- Green energy, energetic autonomy;
- Rising fossil fuel prices;
- Climate change and agriculture;
- Health;
- Food waste;
- Microplastics;
- 2030 Agenda and policies recovery from COVID-19 around the world.
- Lack of technical support in the classroom;
- Political.

Environmental challenges outlined (second challenge):

- Recycling and waste management, landfills;
- Deforestation and the need to increase green space;
- The stress caused by the war between Ukraine – Russia;
- The sea level is rising, which affects coastal areas;
- The energy efficiency of dwellings;
- Contamination of water and depletion of soils due to intensive agriculture;
- Sustainable agriculture;
- Climate change;
- Inflation;
- Pollution and the need for more green space in big cities, improving life in the towns by combating pollution and car traffic;
- Earth-friendly energy sources and lack of investments in green energy;
- Risk of extinction of certain animal and plant species;
- Increased energy consumption;
- Personal involvement in every action;
- Live green;

- Invasive species (harmful species);
- Equity;
- There are a number of water conservation initiatives, including the evolution of the legal and institutional framework, reforming the water supply systems and improving the water sanitation system;
- Guided tours in parks;
- People who make decisions in the educational field are not familiar with what is actually going on in the classroom;
- Sustainable materials;
- End all forms of poverty in the world.

3. Gameplay

This is a problem-based simulation game where teams of students role-play as elite squads of experts tasked with tackling urgent environmental issues. The issues are presented as missions (scenarios) taking place in a shared fictional world: near-future Earth. The game time matches real-world time, i.e., a week in the game's world elapses in seven real-world days. A new scenario is released every two weeks and made available to all teams via the game's web-based portal.

Following the release of a new scenario, students in each team formulate and submit their proposed solution to it using the web-based portal. To do so, the teams will need to conduct independent research (starting from references suggested in the scenario), brainstorm for solutions, choose and develop one and present it according to the specified format (which may vary between the missions).

Ths submissions are then double-blind peer-reviewed using the website, and the best-ranking submissions are analysed by the game development team, who will choose one submission (or multiple similar ones) and integrate it into the game's fictional world. The "winning" team will be rewarded with a custom badge visible in the web interface. This will be reflected in a narrative update, made available shortly before the next mission is released.

Criteria for peer evaluation are as follows:

- **Clarity**: Is the solution understandable and well-explained? (20% of the score)
- **Feasibility**: Can it be done in practice? (30% of the score)
- **Effectiveness**: Will it solve the problem? (30% of the score)
- **Practicality**: Does it make good use of our limited resources? (10% of the score)
- **Novelty**: Is the idea original and creative? (10% of the score)

In addition to the core mechanic outlined above, the game also incorporates basic role-playing elements as an additional gamification element. Specifically, each team has a set of attributes, which start at 1 but whose value can increase over time: Persuasion, Pragmatism, Problem-Solving, Resource Management, and Innovation. These are based on the peer evaluation criteria outlined above: if a team scores among the top 25% in the category, its corresponding attribute increases by one. This acts as a form of aggregated feedback to the teams, highlighting their strengths and areas that may need more attention.

3.1 Game setting

For practical reasons, the game is set in the near future and emphasises realistic scenarios that build on current environmental issues and existing projections. Some of the scenarios will have more of a local flavour, while others will speak to issues experienced globally.

The tone of the scenarios and in-game storytelling is both urgent in order to convey the severity of the issues at hand, but also one that offers players enough hope to avoid demotivation.

This can be presented as a short animated intro with a voiceover:

The year is 2030. Following decades of unheeded warnings and political wrangling, the Earth finds itself amid a full-blown environmental crisis. Yearly periods of extreme hot weather have become the norm even in northern countries, with most regions in the southern hemisphere experiencing food and water shortages. Life expectancy has begun to decrease globally due to pollution and lack of access to clean water. Coastal areas around the globe are going underwater due to sea ice melting, forcing their residents to leave their homes and flee deeper inland.

In an effort to prevent the world from spinning further out of control, the United Nations set up an emergency task force: the UN Anti-Apocalypse Force (UNAAF). Composed of crack teams of experts around the world, UNAAF is on a mission to address environmental emergencies wherever they occur. When a local community or national government reports an urgent issue to UNAAF, its crack-teams race against the clock to think of the best way to prevent an impending catastrophe.

Your team has been accepted into UNAAF and will work with other teams to analyse incoming requests for help. Whenever an urgent issue is reported, the teams will submit their proposed solution to the UNAAF Action Committee, which will choose one solution and dispatch its officers to put it into action immediately. All is not lost yet, and the world's fate is in your hands. Good luck!

Each scenario will be presented in the game as a briefing by a senior officer in the UNAAF headquarters.

3.2 Scenario submission

Scenario ideas may be submitted by teachers from partner schools, as well as members of the development team and invited experts. These will be taken as a basis for new missions, which

will be formulated by the development team, who will write character dialogue, formulate mission objectives, and create game assets as needed.

The submission form will be structured as follows:

Scenario description

Describe your scenario in a few sentences. The scenario must be fictional (taking place in 2030) but rooted in existing, real-life environmental issues.

Requirements

What constitutes success? I.e., what needs to happen for the problem to be considered successfully resolved?

Location

Where in the world is this scenario taking place?

Duration

Does the scenario describe an emergency that requires immediate attention (e.g., an old nuclear dome about to collapse) or a slowly developing situation that needs more prolonged, long-term intervention (e.g., a species on the brink of going extinct)?

Type of problem

Four broad categories: Climate change, loss of biodiversity, pollution and waste, demographic, and agricultural issues

Specific problem

Describe the more specific environmental problem your scenario speaks to in a single phrase. E.g., what kind of pollution (air, water, light, noise, radioactive) or what aspect of climate change (e.g., ice peaks melting, desertification, etc.)?

Possible solutions

Briefly list two or three different approaches to solving the scenario (one sentence per approach). This is needed to ensure there is more than one possible "solution," as the game would be boring if every team followed the same obvious approach. Note that solutions should not rely on futuristic technology that is far from what we currently have available.

References

Provide links to 2-3 articles, videos, podcasts, etc., from reputable sources to which we can refer the players for more information on the issue the scenario explores.

Other notes (optional)

E.g., what kind of considerations are important to emphasise? What kind of additional constraints should be placed on the players? Etc.

3.2.1 Sample scenario

Scenario description

There are several sunken submarines in the coastal areas of the Baltic Sea that have been there since the Soviet era. Their hulls are beginning to decompose, threatening to release radioactive elements into the water. This is a threat to both marine life and people in the coastal communities, especially where there is widespread fishing.

Requirements

The mission is successfully completed if radioactive waste is prevented from spilling into the sea water beyond trace levels and at least in the mid-term (for the next 10 years).

Location

Saaremaa, Estonia

Duration

Short term

Type of problem

Pollution

Specific problem

Nuclear waste in the sea

Possible solutions

1. *Lift the submarine wreck off the seabed and onto the shore (risks further spillage, poses the issue of nuclear waste disposal on land). (Removal)*
2. *Extract the radioactive waste using remote-controlled robots (technically challenging). (capture)*
3. *Build an underwater dome around the submarine. (containment)*

References

https://www.bbc.com/future/article/20200901-the-radioactive-risk-of-sunken-nuclear-soviet-submarines

https://www.youtube.com/watch?v=dXPQ7OsM3PQ

(Possible solutions template)

Pollution can be defined as a man-made product (or by-product) which is in a place that causes damage to the local web of life. This can be either chemical, physical or radiological in nature. Solutions normally fall into a combination of four different types of processes. 1. Containment 2. Removal 3. Neutralisation 4. Capture.

Definitions

Containment - seals off the problem from the rest of the environment.

Removal - moves the thing from one place to another (hopefully where containment can be maintained).

Neutralisation - changes the chemical makeup of the thing to a more stable or safer form.

Capture - the filtration and collection of the target pollutant. (Normally has to be used as a first step to containment).

Conclusion

Based on the results achieved and their feasibility, the BIG_GAME concept and model will have the following features:

- It will be valorised mastery, competition, discovery, and role-play of the students;
- A problem-based simulation where teams of students role-play as elite squads of experts tasked with tackling urgent environmental issues will be encouraged.
- The issues will be presented as missions (scenarios) taking place in a shared fictional world.
- Students in each team will formulate and submit their proposed solution to each scenario
- Regarding the setting: near-future Earth – it is impossible to realise because of the needed artistic license for scenario development. Therefore, it will be preferred fictional environment.

The Game Development Model will follow the schema represented in Figure 14:

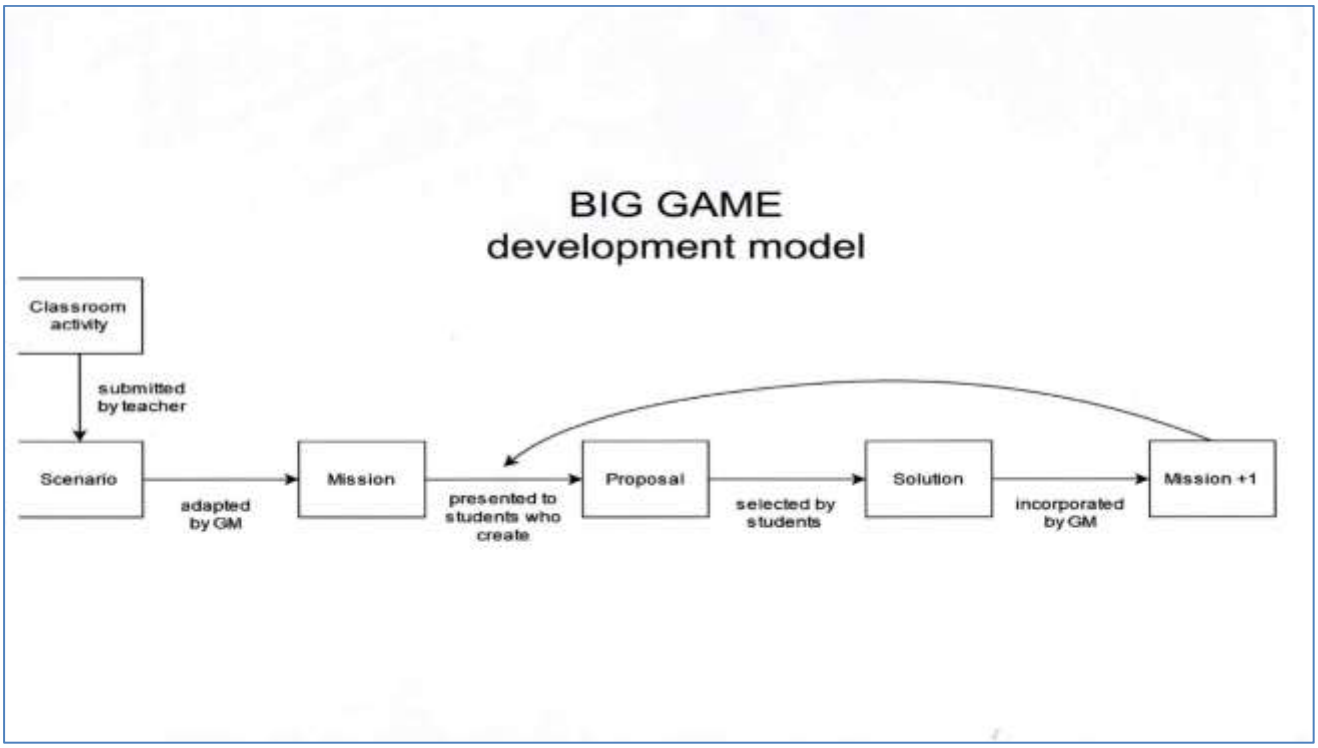


Figure 14 – THE BIG_GAME Development Model