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EDUCATION FOR SUSTAINABLE CITIES

Florence, 29th May 2025

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Francesca Ugolini, Serena di Grazia,
Irene Mari, Elena Palmisano

PROCEEDINGS

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Energy and Sustainability: Role-Playing in the Classroom

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Abstract

Energy is one of the main issues presently faced by humanity. A game-based approach was pursued in two experimental classroom sessions (in a high school and a university course) to let students understand the complexity of the matter. By playing different roles the students understood that: (i) the perception of the sustainability of different energy sources is highly dependent on the scale of analysis (e.g., national or local); (ii) energy is directly or indirectly connected with many political, environmental, social and economic issues; (iii) arguments to support or oppose specific energy sources should be carefully analysed as they may be put forward by pressure groups with a hidden agenda.

Introduction

Energy is a pressing matter, interconnected with many other topics (development, sustainability, climate change, pollution, military conflicts, economics, finance, geopolitics, and so forth). These interconnections are difficult to understand and teach. In recent years, science education has increasingly integrated innovative teaching approaches, recognizing games as an effective tool to facilitate learning and promote active student engagement [1, 2, 3]. In this context, both role-playing games (RPGs) and structured gamified activities have proven particularly effective in teaching complex scientific concepts, including those related to energy and environmental sustainability [4,5]. Role-playing games, in particular, stand out for their ability to simultaneously stimulate the cognitive and emotional dimensions of learning. These educational tools foster the development of transversal skills such as critical thinking, collaboration, and effective communication, thus proving particularly suitable for educational contexts focused on complex socio-scientific issues [6,7]. Many examples can be used to demonstrate how playful methodologies, expressed both through role-playing and traditional educational games, represent versatile and effective didactic tools for

teaching concepts related to STEM subjects, and particularly to the energy topic [8-11]. This work reports on the preliminary testing of a gamified activity conceived to engage high-schools and university students into a debate about energy and related issues, fostering their systems thinking and giving them cognitive tools to identify and defend against biased information. framework including the aim of the study.

Methodology

The activity is targeted at high-school students and university students. It is conceived to be carried out in a whole classroom, it is divided into four phases and it is designed to be completed in a two-hour session.

Phase one: questionnaire – Each student answers individually a questionnaire about his degree of acceptance of a series of energy sources. The most widespread energy sources were included, namely: nuclear, solar/photovoltaic; natural gas; oil; coal; biomass; hydroelectric; geothermal; wind. We included only established energy sources with consolidated literature, in order to retrieve reliable data and supporting information to be used in the classroom debate that will take place in the third phase. The peculiarity of the questionnaire is that the same question about the acceptance of each specific energy source is repeated, shifting among four different points of view. In the first round of questions, the students are asked to imagine they are the Prime Minister, and they have to select different policies about energy sources (e.g. they can ban or they can provide economic incentives to different energy sources). In the second round, students are asked to be the mayor of a large municipality that is about to draft an energy plan, so they can directly oppose or foster different energy sources. In the third round, they are themselves and they are asked to imagine that a medium-size energy plant is going to be built close to their home: how do they react? Would they oppose or support each energy source in this specific case? In the fourth round, they are asked to think about when they will be adults, and they will have to design their own home: how inclined would they be to install a small implementation of the various energy sources considered?

Phase two: political agenda – This phase starts with some storytelling that sets a hook for a debate among students. For some mysterious circumstances the Government and

the President of the Republic have disappeared and a powerful artificial intelligence, when asked how to fill the void of power, selected a random high school or university class to serve as new government. Of course, the selected class is the one where the activity is taking place. The students, as ministers of the new government, are asked to find a consensus among five to ten political priorities (presented as "big problems to urgently address" or "big opportunities to urgently seize"). When the consensus is reached, the list of priorities is written, and a brief discussion follows to investigate if some of them are directly or indirectly connected with energy.

Phase three: proposers vs citizens vs governors – This is the more time-consuming activity, which summarizes an Environmental Impact Assessment (EIA) procedure introducing elements of role-playing and gamification. The class is divided into three groups. First, each group will have to select their "favorite" energy source and propose the implementation of a big energy generation plant, highlighting the advantages. The three groups will have to select three different energies (on a first come first served basis, also to speed up the selection process). In a second step, each group plays the role of the citizens opposing the implementation of the plant proposed by one of the two other groups. They will have to write down (and later, in turns, briefly explain) three main reasons to oppose the project. In a third step, each proposer has the chance to defend their projects: they can rebut the critics received (providing some convincing arguments) or they can propose some mitigation measures to make the implementation acceptable. In the last step, each group acts like the government and decides if the power plant proposed/opposed by the other two groups will be authorized or not. The group is free to decide based on an honest evaluation of the previous debate (proposal – observations – defense) or based on their political agenda (which is the same decided during the second phase of the activity).

Phase four: debriefing – First of all, students want to know who won: points are assigned based on the following criterium (for each power plant): if the power plant is authorized, the proposer scores a point (if it is not authorized, the citizens score a point); each observation gives a point to the citizens (if it is not addressed adequately by the proposer) or to the proposer (if a convincing rebuttal or an effective mitigation measure

is presented); the government scores a point for each point of the agenda reached thanks to the decision made (implementing the plant or not). The teacher makes these assessments, using supplementary material collected in advance (graphics, statistics…). Lastly, a proper debriefing takes place, in which the students can ask questions and clarifications, and the teacher highlights the outcomes of the activity.

Results and discussions

The activity was repeated twice, in a fourth-year scientific high school class (18-19 years old students) and in the "Environmental Impact Assessment" class at the University of Firenze, where both Bachelor and Master students (aged 22-25) are enrolled. We acknowledge that this is not a statistically robust sample, but the purpose of this preliminary test was only to test the game mechanics and the effectiveness of the activity regarding teaching potential, engagement and attraction toward STEM subjects. Therefore, the results are treated in detail without generalization purposes, but just to show which outcomes could be potentially obtained even from a single classroom session.

The results of the first phase are reported in table 1. In general, students opposed fossil fuels (especially coal and oil), while nuclear energy was rather divisive (very negative opinions prevail, but in contrast to all other energy sources, they are partially counterbalanced by very positive opinions as well). The main objective of this phase was to let the students reflect on how opinions can change according to the point of view, scale of analysis, or personal level of involvement. This stands out quite clearly from Fig. 1: the acceptance of every energy source decreased passing from national level (Figure 1a) to municipal level (Figure 1b) and, more notably, to local level (Figure 1c). The local level, in particular, was described during the application as "imagine they are going to build it just 1 km away from your backyard", to properly introduce the NIMBY (Not In My Back Yard) syndrome, that clearly affected the surveyed classrooms: even the energy sources considered as the most environment-friendly and evaluated very positively at the national scale received a general drop in acceptancy level at the local scale.

This outcome was clearly perceived by the students, who questioned and reflected about their intellectual honesty and coherence while shifting points of view. For instance, during both sessions, somebody asked aloud: "When thinking at the national scale I had

reported a positive answer on a certain energy source… can I provide a different answer at the municipal or local scale?". Of course, the answer was "yes", aligning to the game objectives. Lastly, at the "own house" level, Figure 1d shows a rise in acceptancy: in this case the setting was radically changed, as we are focusing here on micro implementations (some of them are hypothetical) to run a single house. Later discussions showed that the generalized positive shift in perception is due to the absence of big visual impacts typical of large power plants and the higher level of trust in a system managed by their own. Notably, many students confessed to favor implementation over another mainly if it was economically convenient.

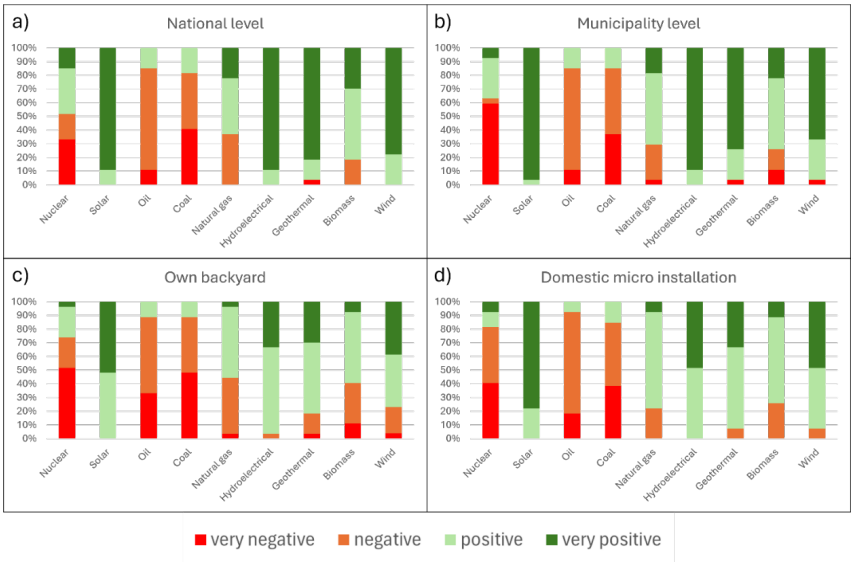

Figure 1. Answers received during the first phase of the activity.

The results of phase 2 are reported quite briefly as they are instrumental to phase 3 and because the sample is too small and biased to allow a generalization. In both sessions, students agreed on themes like social policies, environmental policies (including actions to contrast climate change, foster sustainable development and environmental protection), better welfare, better job opportunities. After selecting the 10 political points, the students were asked to find connections with the topic of energy. Interestingly, at first connections were identified only regarding environmental issues. Only a deeper (and guided) discussion allowed to establish points of contact with topics

initially perceived as completely separated and disconnected. For instance, the high priority topic "stop conflicts and wars" was not included among the ones connected with energy. After a hint to think carefully that if we want to permanently stop conflicts we must understand and fix the triggering causes, students realized that some conflicts around the world are taking place for access to energy sources (e.g., uranium, oil, coal…) or critical materials for energy production. The classes were generally impressed and surprised by this "discovery".

In phase 3, the selected energy sources were solar and hydroelectric (twice each), and wind and nuclear (once each). Students indulged in long debates to defend/criticize energy sources depending on the role they were playing. In most cases, critics were rebutted with technically sound arguments retrieved on the internet or already known by some students. Notably, a common critic to all energy sources was "it's too expansive, or cost/benefit ratio is not good enough". Only the visualization and comparison of official data (€/kWh per energy source both in the near past and in future projections) clarified whose perceptions were reasonably aligned with reality. All students showed to consider the building of new power plants only without greenhouse emissions. A highly criticized point was the visual impact, which was always defended with the necessity of clean energy rather than with an optimized landscape integration, suggesting that landscape planning is still overlooked and it represents maybe a very advanced concept not properly understood by population. Interestingly, besides nuclear, all the other energy sources were selected by the other groups among the top three favorite sources. Notwithstanding, most of the proposals were rejected by the group playing the "governors" role. When asked why, the students either declared "blocking the implementation better fits my political agenda" or stated that the investor didn't completely clear out the arguments raised by the citizens.

This part of the activity was very useful to foster critical thinking, train dialectic skills, and understanding some advanced concepts that could be attractive toward STEM subjects (e.g., learning about recent technological advances or possible mitigation measures). Students also experienced directly that technical aspects are often overlooked, and that public opinion tends to be polarized. Students also understood that the ability to retrieve, analyze and understand scientific data is a fundamental tool for informed decisions and

promotion of sustainability, but unfortunately political aspects or personal agendas can have a stronger weight in decisions or perceptions.

The fourth phase was a final recap and debriefing. A growing body of literature underscores that a debriefing is fundamental for an effective disclosure of the concepts covered by the game and for a long-term retention of the learnt outcomes [12, 13]. Besides the specific points discussed above in the description of the previous phases, some general points came out spontaneously among the students. For instance, they understood quite clearly that the "think global, act local" concept (which is one of the cornerstones of sustainable development at least since the Agenda 21 program) in practice can be easily nullified by the "NIMBY syndrome": students experienced that is way easier to oppose something (even a sustainable project) rather than supporting it. In understanding this, they also learned that the public debate about sustainability can be influenced by biased data, personal opinions, and manipulation of subjective perceptions.

The debriefing was also used to ask for feedback and suggestions for improvement of the activity. The students declared that the best parts of the activity were the moments of debate (phase 2 and 3). Teachers agreed, adding that they were positively surprised about the maturity and seriousness shown by the students during these phases.

We reiterate that this is only a test for the evaluation of the activity, its level of engagement and its teaching potential: the sample analyzed is too small and biased to allow for a generalization of the results to a broader extent.

Conclusions

The feedback collected among students and teachers during the debriefing indicated that this activity has good potential both for teaching and outreach purposes. Therefore, it will be proposed for a wider application in high schools, in the framework of orienteering activities to attract students towards STEM courses at the University. Moreover, based on the positive feedback received, in the framework of an ongoing Erasmus+ project (HUIWORLD), the activity is being included in a learning unit on the topic of "Energy and Earth Sciences".

More specifically, the tests proved that the activity is a valuable tool to teach students of different levels (spanning from high school to bachelor and master students) important

and complex concepts about sustainable energy production and management. In this regard, the role-playing approach was a winning card for its irreplaceable power to let the students/players "wear the shoes" of different groups of interest and have a first-hand experience (even if simulated in a structured game) of different points of view, different hidden interests and diversified interconnections with other important political, environmental and socio-economic issues.

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