Workshop-based Renewable Energy Education for Middle School Students in Southern Brazilian Public Schools

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Abstract

This paper presents the design and implementation of a renewable energy (RE) workshop for middle school students in six public schools in southern Brazil, as part of the project "*Energizing Equity: Girls and Women Empowering the Energy Transition*". Supported by the Ministry of Science, Technology and Innovation (MCTI) and the National Council for Scientific and Technological Development (CNPq), the initiative seeks to strengthen female participation in Science, Technology, Engineering, and Mathematics (STEM) fields while promoting RE education aligned with the Sustainable Development Goals (SDGs) and Brazil's National Common Curricular Base (BNCC). The workshop followed a four-week cycle: literature review, hands-on experiments, technical visits, and dissemination of knowledge. Innovative strategies were adopted, including the development of a customized educational card game inspired by the commercial game Perfil and the creation of mock-ups to facilitate the understanding of abstract energy concepts. Activities explored nine RE technologies: solar photovoltaic (PV), solar thermal, wind, hydroelectric, biomass, hydrogen, wave, tidal, and geothermal, through interactive and collaborative approaches. Results highlight that the integration of gamification, experiential learning, and contextualized practices increases student engagement, enhances critical thinking, and fosters teamwork, while connecting classroom learning to real-world energy challenges. The findings demonstrate the potential of workshop-based gamified activities to advance energy literacy, promote gender equity, and prepare younger generations for an inclusive and sustainable energy transition.

Keywords: Renewable Energy, Gamification, Basic Education, Energy Transition

1. Introduction

In 2024, the renewable energy (RE) sector achieved record-breaking growth, with global installed capacity expanding by 18% through the addition of 741 GW. Solar photovoltaic (PV) was the dominant source, accounting for 602 GW of this increase, while wind energy added 117 GW. Other RE sources, whether used for electricity, heating, or transportation, made only minor contributions to the overall expansion. This dynamic reflects both the accelerating global electricity demand, driven by demographic and economic factors, and the critical role of continued RE deployment in meeting such demand. Global investment in RE reached USD 728 billion in 2024, 8% higher than in 2023. However, this increase was considerably more modest compared to the previous years, when investments grew by 19% in 2023 and 23% in 2022, mainly due to a downturn in wind power financing (REN21, 2025). In the Brazilian context, PV capacity exceeded 59 GW by August 2025, representing 23.5% of the national electricity mix. Unlike global trends, this capacity is predominantly based on distributed generation (70%), with centralized plants accounting for the remaining 30% (ABSOLAR, 2025).

Although the PV sector has expanded, gender disparities persist, with women globally underrepresented in technical and leadership roles. In Latin America and the Caribbean, for example, they comprise only about 20% of the energy workforce, and merely 7% hold leadership positions. In Brazil, this disparity is also evident. In 2024, the PV sector employed around 214,000 professionals; however, 35% of PV companies did not employ women (Greener, 2024). Of those who did, most female employees were employed in non-technical roles, such as administration, finance, or human resources, with also 7% occupying positions in engineering or project development (Schneider et al., 2021).

In this way, the education of professionals commences at an early stage, preceding higher education in basic education. Environmental and RE education can shape individuals' perceptions of the world and influence how they treat and manage it. It serves as both a process and a tool to empower participation and learning across all age groups,

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particularly in young people, using a bidirectional communication paradigm from educators to learners and learners to educators (Hungerford; Volk, 1990). Integrating RE education into school curricula fosters critical thinking and empowers students to become environmentally conscious citizens capable of making informed decisions regarding energy consumption and conservation in their daily lives. This integration underscores the environmental issues and consequences of using non-RE sources (Sulaiman et al., 2023). Consequently, teaching about RE is crucial in raising awareness about their acquisition methods and the rapid growth of electric energy consumption and produced. The subject of energy, more specifically RE sources, is included in the educational curricula in several countries (Colmenares-Quintero et al., 2022; Corina et al., 2024; Hoque; Yasin; Sopian, 2022). Nonetheless, evidence suggests that educational programs still dedicate little attention to RE and Education for Sustainable Development (ESD), which contributes to students' low levels of literacy and engagement in these areas (Agirreazkuenaga; Martinez, 2021; Çakirlar Altuntaş; Turan, 2018; Hoque; Yasin; Sopian, 2022).

One strategy for integrating RE education in the classroom involves the use of gamification, thought the Active Learning Methodology. The Active Learning Methodology seeks to transform students into active participants in the educational process, fostering autonomy, engagement, and critical thinking (Meyers; Jones, 1993). Within this approach, learners are not merely listeners but take on a central role in constructing their own knowledge, while the teacher acts as a facilitator and guide. The main purpose of this methodology is to create dynamic and engaging learning environments that emphasize knowledge construction rather than simple content transmission, thereby enhancing the effectiveness of the learning process. This approach is closely linked to the implementation of practical and experiential teaching methods, offering examples of activities and pedagogical strategies that educators can apply across diverse disciplines and in both formal and informal educational contexts (Kane, 2004). In this way, gamification has emerged as a pedagogical strategy for enhancing learning outcomes in Science, Technology, Engineering, and Mathematics (STEM) education. By integrating elements of game design, such as challenges, rewards, and collaboration, into instructional contexts, gamification fosters motivation, engagement, and active participation among students (Gee, 2003). In exact sciences, where abstract and quantitative concepts often pose learning difficulties, game-based learning provides an interactive environment that encourages experimentation and problem-solving. Furthermore, it promotes a shift from passive knowledge acquisition to experiential learning, enabling students to connect theoretical concepts with real-world applications.

Several studies demonstrate the effectiveness of using gamification to teach about RE and PV. For example, Sulaiman et al. (2024) demonstrated that the digital game Minecraft Education was used as a platform to teach PV concepts to forty high school students in Penang, Malaysia. The game was an effective pedagogical tool for transforming complex scientific concepts into more accessible ones, applying a mixed-methods approach, combining pre-tests, post-tests, and focus group discussions. The results revealed significant improvements in students' comprehension and retention of solar energy principles, as well as increased motivation and engagement in science learning. The authors concluded that integrating game-based environments into science education facilitates conceptual understanding of complex phenomena, making abstract content more tangible and interactive. However, the study also highlighted challenges related to technical infrastructure and the absence of a control group, emphasizing the need for further research to validate the long-term educational impact of gamified learning in RE education (Sulaiman et al., 2024). Several other educational games have also been developed. For example, a board game inspired by *Monopoly* was designed and applied to strengthen students' understanding of PV system operation while fostering teamwork and critical thinking (Meza et al., 2024). Similarly, a role-playing game (RPG) in book format was created to support the teaching of physics (De Sá; Paulucci, 2021). In addition, three different PV toys were produced by redesigning second-hand toys and reusing broken solar modules (Machuve; Mkenda, 2019).

This study addresses gender and educational gaps by implementing a four-week RE workshop in six public elementary schools across Santa Catarina (SC) and Rio Grande do Sul (RS), Brazil in the municipalities of Osório (OSO-RS), Tramandaí (TRA-RS), Santa Maria (SMA-RS), Passo Fundo (PSF-RS), and Florianópolis (FLN-SC). These schools are part of the project *"Energizing Equity: Girls and Women Empowering the Energy Transition"*, a southern Brazilian initiative supported by the Ministry of Science, Technology and Innovation (MCTI), and the National Council for Scientific and Technological Development (CNPq). The project promotes female participation in STEM through thematic workshops on RE, Energy Management, Scientific Methodology, and Gender Equity, aligned with the Sustainable Development Goals (SDGs) (UN, 2015) and Brazil's National Common Curricular Base (BNCC) (Brasil, 2018). This article will focus on the first workshop of RE, to present the different types of RE, their benefits and practical applications. Beyond workshops, the initiative fosters technical, pedagogical, and community practices that enhance RE education, gender inclusion, and science communication. This scenario highlights the necessity for targeted policies and educational initiatives to promote gender equity in the energy transition. Such initiatives must address persistent challenges, including the unequal distribution of employment opportunities, the need for industrial policies to strengthen local capabilities, and the importance of ensuring a just energy transition through inclusive education and skills development programs.

2. Methods

2.1. Case Study

This study aims to present the design and implementation of a RE workshop in six public middle schools selected for the research project "*Energizing Equity: Girls and Women Empowering the Energy Transition*" (www.ufrgs.br/energizandoaequidade), a southern Brazilian initiative supported by the Ministry of Science, Technology and Innovation (MCTI) and the National Council for Scientific and Technological Development (CNPq). Implemented over three years, the project involves 105 students and 21 teachers from six public schools, in collaboration with three federal universities (Universidade Federal do Rio Grande do Sul– UFRGS (https://www.ufrgs.br/), Universidade Federal de Santa Catarina - UFSC (https://www.ufsc.br/) and Universidade Federal de Santa Maria – UFSM (https://www.ufsm.br/)) and professional networks such as the Brazilian Network of Women in Solar Energy (Rede Brasileira de Mulheres na Energia Solar – MESol – https://www.mesol.com.br/), Women in Biogas (https://mulheresdobiogas.org/) and the Regional Council of Engineering and Agronomy of Rio Grande do Sul (CREA-RS – https://www.crea-rs.org.br/). The key actions of the project include mentoring programs linking students and teachers with female energy professionals, participation in scientific competitions and outreach events, the production of educational materials and academic publications, and the development of performance indicators to monitor gender equity and energy efficiency in schools.

Nowadays, the BNCC advocates for a teaching model emphasizing student autonomy and an active, participatory process, including research, collaboration, and knowledge sharing. Students are encouraged to engage in investigative processes during the final years of elementary education and throughout high school. Consequently, the teaching of natural sciences aims to develop several key skills: observing the world and formulating questions, analyzing needs, identifying problems, proposing hypotheses, developing explanations and models, and constructing evidence-based arguments. Furthermore, students are expected to enhance their knowledge by gradually incorporating scientific principles. Studies highlight the importance of these skills in developing citizens who are capable of solving problems and making informed decisions (Da Conceição; Fireman, 2020). In this way, the development project was also aligned with the BNCC (Brasil, 2018), taking into account the skills outlined in Table 1.

Table 1: A range of skills related to different areas of knowledge, focusing on learning subjects related to RE and PV in the middle school curricula used in the project.

KNOWLEDGE OBJECTS	CODE	SKILLS
1 - Sources and types of energy 2 - Energy transformation 3 - Calculating electricity Consumption 4 - Electrical circuits 5 - Conscious use of electricity	EF08CI01	Identify and classify different sources (RE and non-RE) and types of energy used in homes, communities, or cities. The workshops will address the identification and classification of different energy sources, helping students understand the importance of RE.
	EF08CI02	Build electrical circuits using batteries, wires, and a light bulb or other devices, and compare them to residential electrical circuits. Building electrical circuits will be a hands-on activity in the workshops, allowing students to gain a direct understanding of the principles of electricity.
	EF08CI03	Classify residential electrical appliances (shower, iron, light bulbs, TV, radio, refrigerator, etc.) according to the type of energy transformation (from electrical to thermal, light, sound, and mechanical energy, for example). Students will learn to classify and understand energy transformations in everyday appliances.
	EF08CI04	Calculate the consumption of home appliances based on power data (described on the equipment itself) and average usage time to assess the impact of each device on monthly household consumption. Workshops will include practical calculations of energy consumption, promoting efficiency and energy savings.
	EF08CI05	Propose collective actions to optimize the use of electricity in your school and/or community, based on the selection of equipment according to sustainability criteria (energy consumption and energy efficiency) and responsible consumption habits. Students will be encouraged to propose and implement actions to optimize energy use in their communities.
	EF08CI06	Discuss and evaluate electricity generation plants (thermal, hydroelectric, wind, etc.), their similarities and differences, their socio-environmental impacts, and how this energy reaches and is used in your city, community, home, or school. Discussions and evaluations of different power generation plants will be carried out, expanding the students' understanding of socio-environmental impacts.

As shown in Figure 1 below, each participating school was assigned a code, as shown in Table 2. Each school also selected five 9th-grade female students for year-long participation, supported by the project. One teacher was responsible for disseminating content and providing pedagogical guidance throughout the process.

Table 2: Basic information about the schools.

Code	University	School	City/State	Type of school	Quantity of students	Levels of education
S01-FLN-SC	UFSC	Simão José Hess	Florianópolis/SC	State school	919	Elementary and high school
S01-TRA-RS	UFGRS	Assis Brasil	Tramandaí/RS	State school	697	Elementary and high school
S02-TRA-RS	UFRGS	Barão de Tramandaí	Tramandaí/RS	State school	786	Elementary, high and technical school
S01-OSO-RS	UFRGS	Prudente de Morais	Osório/RS	State school	983	Elementary, high and technical school
S01-STA-RS	UFSM	Vicente Farencena	Santa Maria/RS	Municipal school	434	Elementary school
S01-PSF-RS	UFSM	Fredolino Chimango	Passo Fundo/RS	Municipal school	346	Elementary school

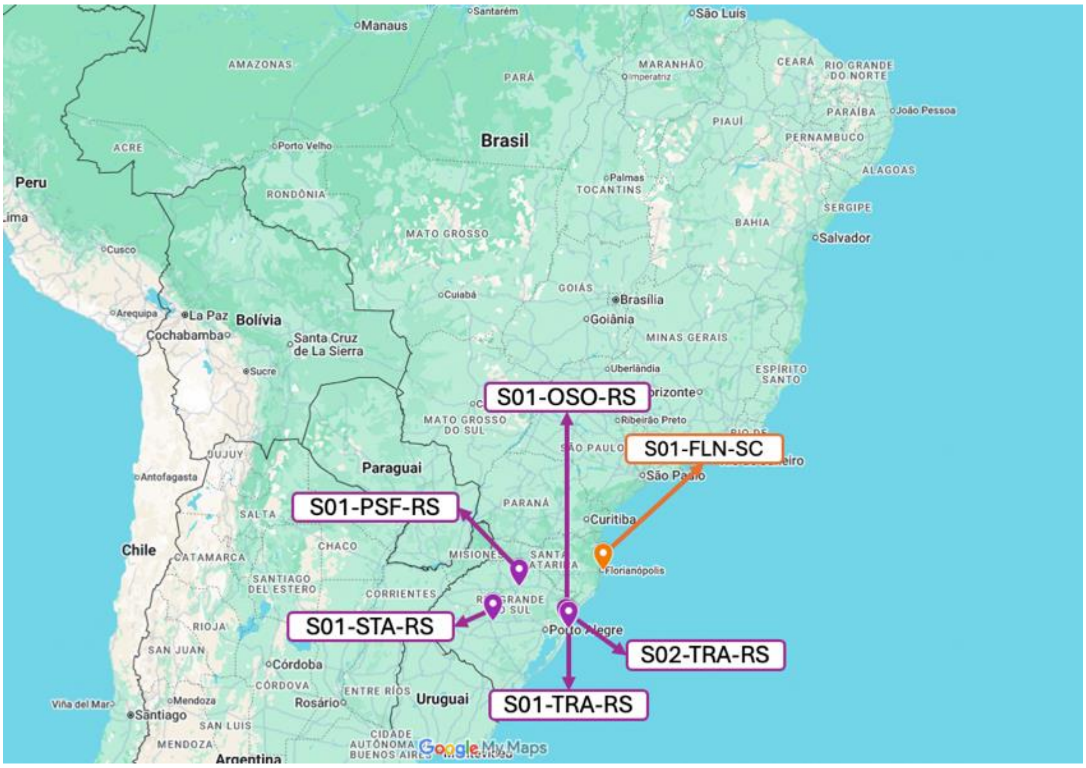

Figure 1: location and code of the six public elementary schools used in the research project.

2.2. Workshop structure

The project comprises four thematically structured workshops addressing RE, Scientific Methodology, Energy Management, and Gender Equity, each delivered over four weeks following a structured sequence:

- <u>Week (1) - Literature review:</u> At this stage, both teachers and students engage in an initial exploration of the selected theme, drawing on reference materials supplied by the Project alongside trustworthy academic and institutional sources, such as books, journal articles, and reports. The purpose of this activity is to establish a foundational understanding of the subject, enhance critical reading and information analysis skills, and facilitate the development of guiding questions and preliminary hypotheses that will inform the learning process in the following weeks.
- <u>Week (2) - Hands-on practical</u>: The hands-on activity is carried out in person by Project members together with undergraduate fellows and school teachers. This stage provides students with the opportunity to apply the knowledge acquired during the literature review through experiments, interactive exercises, and group-based dynamics. It emphasizes practical and collaborative learning, creating meaningful connections between theory and practice, while fostering curiosity and active engagement with STEM disciplines.
- <u>Week (3) - Technical visit</u>: The third stage consists of a Technical Visit to an institution related to the workshop theme, such as universities, laboratories, power plants, or museums, in each project region. This

activity connects students to the daily practice of scientific and technological professionals, broadens their understanding of potential academic and career paths, and highlights the real-world applications of the knowledge acquired in class.

- Week (4) - Dissemination of knowledge: The final week of the cycle focuses on knowledge dissemination. In groups, students present what they have learned to peers and the school community using diverse formats such as posters, slides, videos, performances, or artistic productions. This stage enhances students' protagonism in creating and sharing knowledge, strengthens their scientific communication skills, and fosters the integration of school and community in discussions on energy, equity, and science.

The objective of the RE-workshop was to present the different types of RE, their benefits, and practical applications. The following activities were considered: Visits to solar and wind energy facilities at UFRGS, UFSM, and UFSC, proposals for feasibility studies on the implementation of solar thermal water heaters and biodigesters in schools, construction of a prototype solar thermal water heater and a biodigester, experiments with mini-turbines, and debates on sustainability.

2.3. Card Game

As part of the RE workshop materials, the project team developed a custom educational card game to support the learning of RE concepts. The game was inspired by the structure of the commercial game "Perfil" and consists of a series of cards, each representing a specific RE technology (e.g., solar PV, wind, biomass).

The development of games to support classroom instruction is outlined in the BNCC (Brasil, 2018). In this article, the following general competencies of basic education were considered in the methodology:

- Competence 2: Exercise intellectual curiosity and use the approach specific to science, including research, reflection, critical analysis, imagination, and creativity, to investigate causes, develop and test hypotheses, formulate and solve problems, and create solutions (including technological ones) based on knowledge from different areas. In this way, the card game encourages logical and critical thinking by requiring students to interpret clues, construct hypotheses, and test answers.
- Competence 5: Understand, use, and create digital information and communication technologies critically, meaningfully, reflectively, and ethically in various social practices (including school practices) to communicate, access, and disseminate information, produce knowledge, solve problems, and exercise leadership and authorship in personal and collective life. By using active methodologies such as games, scientific and technological literacy is promoted, linked to the use of new languages and educational resources.
- Competence 6: Value the diversity of knowledge and cultural experiences and acquire knowledge and experiences that enable you to understand the relationships inherent in the world of work and make choices aligned with the exercise of citizenship and your life plan, with freedom, autonomy, critical awareness, and responsibility. Thus, the game involves group collaboration, stimulating cooperation, protagonism, and decision-making skills.
- Competence 10: Act personally and collectively with autonomy, responsibility, flexibility, resilience, and determination, making decisions based on ethical, democratic, inclusive, sustainable, and supportive principles. Addressing the different forms of RE brings students closer to debates on sustainability, climate change, and a fair energy transition.

During the design phase, the mechanics of the game were adapted from the original *Perfil* format to promote active participation, problem-solving, and collaborative learning. Each card was structured with a sequence of clues that progress from general characteristics to more specific technical information, stimulating curiosity and critical thinking. The content of the cards was carefully selected to align with the main themes of the workshops, while the overall dynamics were designed to balance competition and cooperation, encouraging student engagement and reinforcing teamwork. Content validation was conducted in consultation with subject-matter experts and schoolteachers, who reviewed the accuracy of the information and its suitability for the students' cognitive level.

3. Results and Discussions

3.1. Game Approach

Table 3 presents a comprehensive list of all cards developed for the "Profile for Renewable Energy" game. Each card is assigned to a specific category, and five clues are provided to facilitate the identification of the card. The answer key for each card is also presented. Figure 2 presents the A6-sized visual model of the cards utilized in the classroom.

Table 3: Complete set of game cards used in the educational activity "Perfil for Renewable Energies"

Answer	Clue 1	Clue 2	Clue 3	Clue 4	Clue 5
PV module	I can be made of silicon	My efficiency can be affected by dirt and shading	I am present on rooftops, solar plants, and even satellites	I convert sunlight into electricity	There can be thousands of me in a PV system
Wind turbine	I am the main equipment of one of the most important RE sources in the world	I can be found on land or at sea	I am located in high and open areas	Together with others, I form a wind farm	I look like a giant fan
Electrolyzer	I am a machine used to split water into two gases	With me, it is possible to produce hydrogen in a clean way	I use electricity to do my work	I am present in green hydrogen production	My name comes from the process called electrolysis
Fuel cell	I transform hydrogen into electricity	I only release water and heat	I can be used in cars and buses	I am very important for the energy transition	I am part of the energy transition
Battery	I am present in cell phones, flashlights, and cars	I am essential in RE storage systems and electric vehicles	I can be recharged many times, but my capacity decreases over time	My health worsens if not properly maintained	I am used to store energy that can be released when needed
Biodigester	I am used to accelerate the decomposition of organic matter	I can be large or small	I can be made of masonry, metal, or canvas	I need proper conditions to work well	I can be Chinese, Indian, Canadian, or have another name
Sun	I am giant and made of gas	My activity affects Earth's magnetic field	Without me, plants could not perform photosynthesis	You see me rise in the east and set in the west	My energy is used by PV modules
Hydrogen	Research is being done so that in the future I can power cars and airplanes	I am a very light gas	I can be used as a fuel	When I am 'green', I come from clean and RE	I am the first element in the periodic table
Light	I can be an electromagnetic wave	I can be a particle	I travel very fast, faster than anything in the universe	When I enter a prism, I can split into several colors, like a rainbow	I am generated by the Sun but can also be produced by lamps
Wind	I am caused by atmospheric pressure differences	I influence weather and global atmospheric circulation	I am one of the factors that determine ocean currents	My movement ranges from breezes to hurricanes	Studying me is essential for weather forecasting, agriculture, and wind power generation
River	I play an essential role in one of the main sources of electricity in Brazil	I can be dammed, diverted, or channeled to feed turbines	My seasonal variations directly influence the national energy matrix	I get full when it rains	The Amazon is the largest of me
Water	I am essential for life	I run in rivers and fall in waterfalls	In my natural form, I am transparent	I am used for drinking, bathing, and swimming	I can generate electricity through hydropower or H2 production
Reservoir	I am like a big lake	Sometimes I become a place for fishing or recreation	My water makes turbines spin	I store water for power plants	I am part of a hydroelectric plant
Electricity	I can be dangerous if not used carefully	I come from various sources such as the sun, wind, and water	I am invisible but powerful	I can be converted into light, heat, motion, and sound	I travel through wires to your home
Global warming	I am directly linked to the excessive use of fossil fuels	I cause glacier melting, sea level rise, and extreme climate events	I can be mitigated with RE, reforestation, and pollution reduction	I am mainly caused by emissions of gases like carbon dioxide and methane	I am related to the increase of the Earth's average temperature over time
Ocean wave	I can travel long distances without significant energy losses	One cause of my formation is wind action	I am one of the most powerful natural phenomena on the planet	I never stay still	My forecasting influences navigation, fishing, and surfing
Biodiesel	I can have food as raw material	I can be blended with fossil fuel	I am used in trucks, tractors, and some cars	An alcohol is used in my production	In Brazil, I am mainly produced from soybeans
Ethanol	I can have food as raw material	I need bacteria to be formed	I can be added to gasoline	In Brazil, I am mainly produced from sugarcane	I am used in FLEX cars
Power grid	I can be underground or overhead, depending on the region	I am essential for electrical appliances	My infrastructure is divided into generation, transmission, and distribution	I connect power plants to homes, businesses, and industries	I am the system that delivers electricity to your home

Biomethane	I can be produced from food waste	I need microorganisms to be formed	I can be added to natural gas	I have 99.9% purity	I am used as a substitute for CNG
Soybean	I am used in biofuel production	I am a plant	I require large areas to be cultivated	Many argue I should not be used to generate energy	I am one of Brazil's main agricultural exports
Overtopping device	My classification depends on installation depth or technology	I can be fixed or floating	I have a ramp	I store water in a reservoir	I return water to the ocean through a turbine
Tidal power	I am clean and RE	My implementation cost is high	I require at least a 7-meter tidal range	I convert kinetic energy into electricity	I generate power through dams or submerged turbines
D am	I am an artificial obstacle	My purpose is to block, reduce, or modify a watercourse	I have a turbine and a gate	I am used to hold or store water	I can also be used for tidal energy generation

Figure 2 shows six examples of the cards developed through this research. The template of the cards developed within the scope of this project is publicly available for educational purposes at www.ufrgs.br/energizandoaequidade. The material must be used in its original form, without modifications, and appropriate attribution to both the project "*Energizing Equity: Girls and Women Empowering the Energy Transition*" and the corresponding scientific publication is required in all instances of reproduction or dissemination.

Figure 2: Example cards of the game developed for application in the RE workshop.

This methodological approach ensured that the game was not only entertaining but also served as an effective learning tool, integrating gender equity and RE education within a playful and interactive format.

3.2. RE-Workshop

As a result of the project, the RE workshop explored nine technologies through an interdisciplinary approach, including solar PV, solar thermal, wind, hydroelectric, green hydrogen (H_2), wave, tidal, biomass, and geothermal energy (Figure 3 and 4). Table 4 presents a comparative overview of the implementation across participating schools.

(1) S01-STA-RS school **(2)** S01-PSF-RS school **(3)** S01-FLN-SC school

Figure 3: Workshops about RE educational activities conducted in April 2025.

(1) S01-FLN-SC school **(2)** S01-TRA-RS and S02-TRA-RS school **(3)** S01-OSO-RS

(4) S01-STA-RS school **(5)** S01-PSF-RS

Figure 4: Technical visits about RE educational activities conducted in April 2025.

Each school decided to create its knowledge dissemination material separately, as shown in Table 4. Schools S01-FLN-SC, S01-OSO-RS, and S01-TRA-RS chose to develop models to represent wind and PV power plants, as shown in Figure 5.

The use of physical models and mock-ups in education plays a crucial role in enhancing students' comprehension of abstract concepts. By providing a tangible and visual representation of complex systems, such as RE technologies, mock-ups bridge the gap between theory and practice, connecting to real life. They foster active engagement, stimulate curiosity, and encourage problem-solving by allowing learners to manipulate, observe, and concretely test ideas. Moreover, these tools support interdisciplinary learning, promote collaboration, and contribute to the development of spatial reasoning and critical thinking skills, which are essential in STEM education.

Table 4: Implementation Details of the Renewable Energy Workshop in Selected Educational Institutions

School/Week	(1)	(2)	(3)	(4)
S01-FLN-SC	An initial study of RE was conducted using the material provided by the project's researchers	A two-to-three-hour face-to-face workshop led by a researcher , with a game developed specifically for this project.	Fotovoltaica/UFSC Laboratory (fotovoltaica.ufsc.br/)	A scale model
S01-TRA-RS			PV power plant at UFRGS Litoral Norte Campus	A scale model
S02-TRA-RS				A folder on RE and to adapt a school robotics kit by changing the energy source
S01-OSO-RS				A scale model and poster
S01-STA-RS			Biodiesel production company – BE8 energy (www.be8energy.com/)	A scale model
S01-PSF-RS			PV power plant at UFMS Central Campus	A scale model

(1) S01-FLN-SC school **(2)** S01-OSO-RS school **(3)** S01-TRA-RS school

Figure 5: Mock-ups develop at week 4.

4. Conclusions and Future Work

This study demonstrates that educational initiatives developed through partnerships between universities, institutions, schools, and government bodies can significantly influence elementary students' understanding of RE and their perception of the broader energy transition. The integration of hands-on experiments, gamified learning, and technical visits proved to be an effective and inclusive pedagogical approach that bridges theoretical content and real-world applications. These activities not only enhanced students' engagement, collaboration, and critical thinking but also fostered awareness of sustainability and energy efficiency in everyday life.

The findings highlight that combining experiential and game-based learning methodologies strengthens energy literacy and aligns with the competencies proposed by BNCC. Moreover, the active involvement of female students in all stages of the workshops reinforces gender inclusion as a key driver for promoting equitable participation in STEM and energy-related fields.

Future work will focus on scaling and refining the model across the subsequent workshops on Scientific Methodology, Energy Management, and Gender Equity. Each module will build on the current framework to deepen conceptual understanding, enhance pedagogical strategies, and assess long-term behavioral impacts related to energy use. The outcomes of this initiative directly contribute to advancing the SDGs, particularly SDG 4, SDG 5, and SDG 7, and strengthen the foundation for a just and inclusive energy transition.

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