University outreach during the pandemic: digital technologies to teach energy efficiency and climate protection[1]

Ruana Tomaz de Souza[2]
ORCID: 0000-0002-1507-7938
Kátia Cilene Rodrigues Madruga[2]
ORCID: 0000-0001-7556-1820
Reginaldo Geremias[2]
ORCID: 0000-0001-8582-5877
Mônica Knöpker[3]
ORCID: 0000-0003-0766-1621

Abstract

This research aimed to evaluate the implementation of a university outreach initiative involving digital technologies toward elementary and middle-school students' awareness of the rational use of energy and climate protection conducted during the Covid-19 pandemic. Therefore, we developed a short course, taught remotely, with twenty students from ten to thirteen years old enrolled in schools from the state system of Santa Catarina in the city of Araranguá. For this course, we developed didactic materials about the following themes: a) energy sources and emissions, b) transport energy and emissions, and c) energy efficiency and climate protection. From the data collected, we could see that the approach to energy efficiency and climate protection themes can contribute to developing perceptions about reducing environmental impacts. We have also identified the importance of contextually approaching these themes, as proposed by the course, to facilitate students' learning and their transmission of necessary knowledge to their families regarding each person's role in environmental protection. Hence, we can conclude that university outreach is an opportunity to approximate schools from the academy in building methodologies that lead to the teaching and learning of different topics and, perhaps, the adoption of new habits, mainly in the case of environmental education. Furthermore, we concluded that digital technologies are powerful tools for implementing outreach initiatives in pandemic contexts.

1- All the data grounding the results of this work is available at *Repositório Institucional da Universidade Federal de Santa Catarina* (UFSC) and can be accessed at https://tede.ufsc.br/teses/PGES0027-D.pdf. English version: Viviane Ramos - vivianeramos@gmail.com

2- Universidade Federal de Santa Catarina, Araranguá, SC, Brazil.
Contacts: ruanatomaz@hotmail.com; katiamadruga08@gmail.com; reginaldogeremias@gmail.com
3- Instituto Federal de Santa Catarina, Araranguá, SC, Brazil. Contact: monica.knopker@ifc.edu.br

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Keywords

Remote education – Pandemic – Covid-19 – University outreach – Energy efficiency – Climate protection

Introduction

On March 2020, the World Health Organization announced the pandemic caused by the new Coronavirus, which changed the reality worldwide. COVID-19 quickly spread. The countries were not ready to deal with its impacts and the new demands that emerged in health, economy, politics, education, and many other areas (HISCOTT *et al.*, 2020).

In Brazil, states and cities faced this public health emergency differently, many regulated by decrees and other legal and regulation instruments. An example is Report nº 5, from June 01, 2020, by the *Conselho Nacional de Educação* [National Education Council], which guided the reorganization of the school calendar due to social isolation measures. Among the possibilities to fulfil the minimum study load, the document cites non-presential activities, mediated or not[4] by Information and Communication Digital Technologies (BRASIL, 2020a).

Schools sought to adapt to the challenges that arose with this new reality. The teachers started to plan and implement pedagogical practices that could be enacted remotely without jeopardizing the teaching-learning quality. This occurred repetitively, as they needed to adjust quickly to the new conditions imposed by the pandemic (VALLE; MARCOM, 2020), proving to be an extremely complex process.

Considering this, the university could be a potential ally due to its character. Mainly because, according to *Law nº 9.394*, from December 20, 1996, which established the Guidelines and Bases of National Education, one of the ends of higher education is to "stimulate the knowledge of current world problems, mainly national and regional ones, provide specialized services to the community, and establish a reciprocity relationship" (BRASIL, 1996, art. 43). Furthermore, this same law mentions that the end of higher education is to:

> [...] act in favor of K-12 universalization and improvement through the education and training of professionals, the conduction of pedagogical studies, and the development of outreach activities that approximate both school levels. (BRASIL, 1996, art. 43).

Thus, as centers of scientific and technology production, higher education institutions can act in favor of K-12 education through outreach, one of its pillars, together with teaching and research. For example, it is possible to develop methodologies that answer, mainly, the situation experienced due to the pandemic. However, we should note that

4- In consonance with Report nº 9 from June 08, 2020, by the National Council of Education, the non-presential activities are those conducted by the educational institutions with the students when their physical presence in the school environment is impossible. The activities can be done in the following ways, photocopied material with activities handed to students in the educational institution; remote classes using different social media; platforms such as Zoom, WhatsApp, etc. (BRASIL, 2020b).

university outreach should be understood as something other than knowledge transfer, as if the university held a higher knowledge and, therefore, would be able to solve the population's problems (FRAGA, 2017). In this case, outreach can articulate the knowledge produced by the university with that of K-12 professionals.

However, how can one implement university outreach for a specific niche of K-12 education, elementary and middle school, during the pandemic of Covid-19? Digital technologies presented themselves as an alternative as, according to Lopes and Melo (2014), they are usually an attractive resource for students in this age range. Moreover, using this technology in favor of pedagogical actions can contribute to teachers and students speaking the same language (MOREIRA; SCHLEMMER, 2020). Besides this, it is crucial to consider that one of the general competencies of K-12 education proposed in the Common National Curriculum Framework is directly connected to understanding, using, and creating digital technologies in a critical, meaningful, reflexive, and ethical way in different social practices, to play diverse roles including problem-solving, protagonism, authorship, and others (BRASIL, 2017).

Among endless themes that could be addressed by university outreach in elementary and middle school, we highlight energy and how it can be used efficiently and promote climate protection. After all, energy production is one of the most discussed themes worldwide. When not sustainable, energy production can negatively impact local communities and the whole planet. However, in Brazilian elementary and middle schools, energy efficiency and climate protection are not commonly treated themes (VIDO; DEGASPERI; NARDY, 2016).

Based on this, we aimed to evaluate the implementation of a university outreach course involving digital technologies to raise students' awareness about the rational use of energy and climate protection. The course occurred during the Covid-19 pandemic. Therefore, we developed a short course, taught remotely, in which students from two schools from the state system of Santa Catarina in the city of Araranguá. This article presents the research in the following sections: a) theoretical reference: pandemic and the remote context; energy efficiency and climate protection; digital technologies and remote education; b) methodology; c) results and discussion; and d) final remarks.

Theoretical reference

Pandemic and remote education

Like other sectors of the society, schools also suffered the impacts of the Covid-19 pandemic. On March 17, 2020, the state government of Santa Catarina published Decree n° 509, suspending school activities for 30 days (SANTA CATARINA, 2020a). However, the contamination spread, and the lack of hospital beds and personnel to attend to the patients demanded the suspension of in-person classes. This context required teachers and managers to take measures to avoid further learning losses. Thus, the organization of remote teaching started[5].

5- As Araújo and Fahd (2020, p. 39), we understand remote education as "[...] a set of emergency activities planned and executed through virtual tools or other available means to minimize the impacts of in-person class suspension".

Faced with this scenario, one of the solutions found was using pedagogical strategies that could be held in this format, mainly using the Internet[6]. This alternative involved different digital technologies, usually attractive to students, allowing various interactive and meaningful activities. Furthermore, it avoided interrupting the learning-teaching process. However, its implementation made students' social conditions even more evident, considering that not all had access to the technologies needed to participate in the classes (STEFANIAK, 2021).

This issue was discussed by Charczuk (2020), who identified the two focuses of criticisms of remote education. One is Brazilian socioeconomic inequality and the consequent lack of access by part of the population to essential resources to follow the activities. The other focus mentioned by the author for such criticisms refers to the alleged better quality of in-person education compared to remote one. Regarding elementary and middle school, Charczuk (2020) also calls attention to the fact that, on the one hand, remote classes can narrow the bonds between parents and children. On the other, there may not be a separation between mother/teacher and school/home, which can lead to difficulties, as school is a place to meet other children, differently from home, a place shared with the family.

Amidst this context, the state of Santa Catarina, together with the State Secretary of Education (SED), the National Council of Education Secretaries (CONSED), and the company Google provided access to the platform *Google for Education* so that the remote classes could take place. Among its tools is *Google Classroom*, which offers several resources, such as creating interactive presentations, forms with learning paths, etc. (SANTA CATARINA, 2020b). In the case of this research, the resources of this tool were used to work with a critical theme of individual and collective development: energy efficiency and climate protection. In the following subsection, we will present this topic.

Energy Efficiency and climate protection in the education context

The *Plano Nacional de Energia* (PNE- National Energy Plan) 2030 indicates several changes occurred in the global energy environment. These changes justify the need to re-examine the evolution of the Brazilian energy system in the long run, considering other renewable sources in energy production (BRASIL, 2007).

The discussions and the influence of the climate change theme have justified studies in different areas, for example, transport aiming to introduce hybrid or electric vehicles. Still, the Reference Term to create the PNE 2050, in the working framework, cites studies in which specific issues should be discussed, such as: "[...] climate change, new technologies, and energy efficiency: influence in the economy due to new technologies, the evolution of discussions on climate changes, and their impact in the economy" (BRASIL, 2013, p. 6).

Studies on these questions are essential, mainly because greenhouse gas emissions are associated with climate change and energy production. Consequently, mitigation measures should be taken (BRASIL, 2018).

The study *Capturing the Multiple Benefits of Energy Efficiency*, published by the International Energy Agency (IEA), points out that energy efficiency measures can postpone the 2°C increase in global temperature until 2050. Non-governmental organizations, such

6- In Santa Catarina, besides using digital technologies, a strategy of creating photocopied materials was created. The schools distributed these materials to their students.

as the *World Wild Fund* (WWF), point out that a 2°C increase would be enough to cause the loss of *habitats* and species. Moreover, it could increase extreme climate phenomena such as rains and droughts.

Regarding climate protection Vido, Degasperi, and Nardy (2016) advocate that this theme must be part of citizens' formation, i.e., the values of environmental protection must be present in school curricula, becoming a part of students' lives. Besides this, the Curriculum Proposal of Santa Catarina highlights the importance of environmental education, considering the negative environmental impacts, such as the contamination of the air, water, and soil, among other problems that affect our society (SANTA CATARINA, 2014).

Considering this issue, the educational process should approach the energy efficiency and climate protection themes mainly to understand the current environmental impacts caused by human action and the actions to be taken to revert this scenario. The university outreach can assume a crucial role in these themes to reach the classrooms and, consequently, students' families, according to the Curriculum Proposal of Santa Catarina regarding formal environmental education. In the following subsection, we will discuss this subject.

University Outreach

The idea of university outreach emerged in Europe in the last century. These teaching institutions sought greater dissemination of the technical knowledge acquired by its academics, thus, allowing the population to reach more information on several themes.

The idea that the university would have a role in disseminating and sharing knowledge expanded, thus, making more accepted the proposal that the knowledge built in the academy would be useful outside its wall, giving way for university outreach (SILVA *et al*., 2019). Melo *et al*. (2020) clarify that university outreach aims to provide society with the knowledge acquired in the academy. In other words, it can affect the education of society.

The 1988 Federal Constitution, in Article 207, states that universities must maintain the inseparability of teaching, research, and outreach (BRASIL, 1988). More than a moment of practical activity based on university studies, outreach approximates students from the surrounding communities. Hence, associating teaching and research and avoiding academics to have an alienated view of the world (SANTOS; ROCHA; PASSAGLIO, 2016).

Good professionals should know the reality of their surroundings to develop strategies to improve the population's living conditions. Under this perspective, outreach can be understood as an opportunity from which universities stimulate academics to socialize and share knowledge and information with the academic community and the general population, assuming an essential social role (MOIMAZ *et al*., 2015).

In such a complex context, as experienced in the case of the Covid-19 pandemic, which demanded adaptations of the schools to fulfil their role, among them the use of digital technologies, university outreach can be an ally. It is possible to develop methodological strategies or specific materials for virtual environments for different phases of K-12 education from initiatives connected to it.

Regarding digital technologies, in the next subsection, we approach some particularities to be used in remote learning.

Digital technologies and remote learning

As previously discussed, the Covid-19 pandemic affected multiple areas, including education. In this area, the impacts were mainly felt due to the suspension of classes and the consequent use of new educational methodologies (LEITE; LIMA; CARVALHO, 2020).

The recommendation of the Ministry of Education to close schools was quickly obeyed. In this new reality, teaching strategies were mainly supported by digital technologies. This happened to reduce educational losses, maintaining students in contact with school knowledge in an alternative way (SANTOS JUNIOR; MONTEIRO, 2020).

Hence, the institutions, schools, and students had to adapt, leaving in-person education and entering the virtual world. This process occurred suddenly, raising doubts about the quality of the education offered, the students' development, and the best technological tools to be used in that context (SANTANA; SALES, 2020).

We must remember that digital technologies are not materialized only through computers with an Internet connection. Countless tools, such as *smartphones*, *tablets*, and various applications, can be used for remote education. Besides that, to a certain measure, current generations use these technologies daily. Therefore, most students did not face significant difficulties in understanding their use. Many were glad to follow their educational processes at home, using these tools (QAZI *et al.*, 2020).

However, the technologies that can stimulate students' education and development can also, as previously mentioned, further the gaps between students from different social classes, even more than during in-person education. Despite the ease of use, a large part of the population does not have access to their Internet and technological resources. Thus, besides the pandemic impacts in other areas, this part of the population lives with limitations imposed by their life conditions and the lack of access to these educational resources (LIVARI; SHARMA; VENTA-OLKKONEM, 2020).

Finally, it is noteworthy that, for Charczuk (2020), the teaching model, whether in-person or remote, does not guarantee the learning development of the didactic-pedagogical proposal but the theoretical conceptual models that support it. Furthermore, in the case of remote teaching mediated by digital technologies, during planning, we must be careful with the specificities of the technological tools used and the activities proposed, as they should motivate and attract students' attention (PAVÃO; ROCHA; BERNARDI, 2019). We have tried to do so when planning and implementing the short course we will present next.

Methodology

This study sought to answer the following research problem: How can university outreach raise the awareness of elementary and middle school students for the rational use of energy and climate protection using digital technologies in the context of the COVID-19 pandemic? For that, we developed an exploratory qualitative investigation using action-research.

To collect data, we implemented a short course using digital Technologies with synchronous and asynchronous activities. The course was registered as an outreach activity of the Energy and Sustainability Department of UFSC.

The research participants, i.e., the course's target group, were composed of students from Years 6 and 7, from 10 to 13 years old, enrolled in two schools from the public state system of Araranguá, the state of Santa Catarina, Brazil. These schools were university partners in the outreach project. We chose them because the first author of this article works as a Science teacher there.

As informed, the platform used to implement the course was Google for Education, made available for the public schools by the government of Santa Catarina. The synchronous classes took place via Google Meet. The content planning considered the National Plan of Energy Efficiency and the National Plan of Climate Change.

The course activities were planned and implemented between August and October 2020. Initially, we created a folder to publicize the short course (Figure 1). This material was forwarded to the students via WhatsApp, with a link that guided them to a survey at Google Forms, so those interested could enroll.

Figure 1 – Folder to publicize the short course[7]

Source: Research data.

The short course consisted of a didactic sequence with Three Pedagogical Moments: initial problem, knowledge organization, and knowledge application (DELIZOICOV; ANGOTTI, 1994). Table 1 presents the objectives and activities of each meeting, as well as their respective moments. All meetings presented in the table were recorded for registration and analysis, such as students' participation and interest in the activities developed.

7 Translation note: UFSC Connected to the Schools; Digital contents in Energy and Sustainability; Short course: Energy Efficiency and Climate Protection; Open enrollment from 19/05 to 10/09. 10 places for each school; Enrollments by order of arrival; The course will take place between 10/12 and 10/16.

Table 1 – Summary of the didactic sequence implemented in the course

Pedagogical moment	Online meeting	Objective	Activities
Problematization	1	Express previous knowledge of energy efficiency and climate protection.	Welcome; Presentation of course and members; Presentation of participants; Questions about energy efficiency and climate protection; Send the first booklet* and the game Caminhos da Energia e as Emissões [Energy and Emission Pathways] created with questions and answers.
Knowledge Organization	2	Perceive the pathways of energy and emissions through booklets and the game.	Discussion on the topic of the first booklet ; Filling the Jamboard with students' reports; Send the second booklet; Task: What called most your attention on the second booklet?.
	3	Identify information on transportation and emissions through the booklet.	Discussion on the topic of the second booklet; Filling the Jamboard with students' reports; Presentation of the third booklet. Task: What do you think can be done to reduce energy consumption in your house or school?
Knowledge Application	4	Express the acquired knowledge throughout the didactic sequence (short course).	Discussion on the topic of the third booklet; Presentation of the answers to the task; Chat about energy efficiency. Invitation to join a planting campaign in 2021.

*The booklets cited in this article are available at the following link: https://drive.google.com/drive/folders/1P5_s2cL7YBqWW9YjfM4or6nwm5z_xPub?usp=sharing.

Source: Research data.

The table shows that the three booklets were used as didactic material during the course. These booklets were created with the help of an undergraduate in Energy Engineering from *Universidade Federal de Santa Catarina*. The themes approached were: energy and emission pathways (Booklet 1), energy for transport and emissions (Booklet 2), and energy efficiency and climate protection (Booklet 3).

Besides this, as a didactic material, we used a digital game entitled *Caminhos da Energia e as Emissões* [Energy and Emissions Pathways] created with the collaboration of a computer technician. This game was composed of ten questions. The first asked for students' names and their schools. The others referred to the contents presented in the first booklet. The students received a link to access the game.

The legal guardians of the students in the course had to sign a term of consent[8] for students to participate. The term was given to them together with a seeding of a native tree, which should be planted following one of the activities to contribute to capturing carbon dioxide in the atmosphere.

8 - The term signed by students' guardians considered the possibility of using the data collected in the course in the dissertation that originated this article and future publications based on this study (Document available at https://repositorio.ufsc.br/handle/123456789/221345).

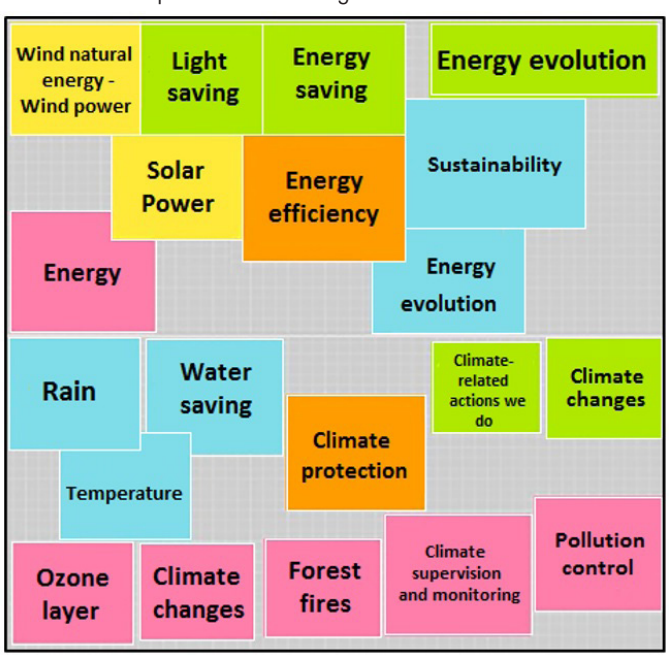
Results and discussion

From the implementation of the course, we reached some results. These results were collected by observing students, their oral contributions, and the other activities developed during this initiative. Besides this, it is important to say that not all results will be presented in this article due to the characteristics of this type of text[9].

Initially, we questioned students' motivations to participate in the course, as it was not obligatory. The students answered: "To be well-informed", "Because we will get in contact with the university and get a certificate", "I think the theme is cool and interesting", "A chance to learn more", "I like to learn about new things", "I would like to learn more about this topic", "I like new things, and it is a contact with the university". Through these answers, we can perceive three critical points. First, the students were interested in the theme proposed. Second, they like to learn. Third, the university was an important factor in the enrollment decision. Besides these points – interest in the theme, wish to learn, and connection school-university – we should add that when the course took place, the students' schools were not offering remote activities yet. Therefore, the course could also be an opportunity for them to meet each other, even if virtually.

In the first meeting, we asked what they understood by energy efficiency and climate protection to identify students' previous knowledge about the themes to be discussed. Their answers were written on the *Jamboard* (Figure 2).

Figure 2 – Notes about students' previous knowledge

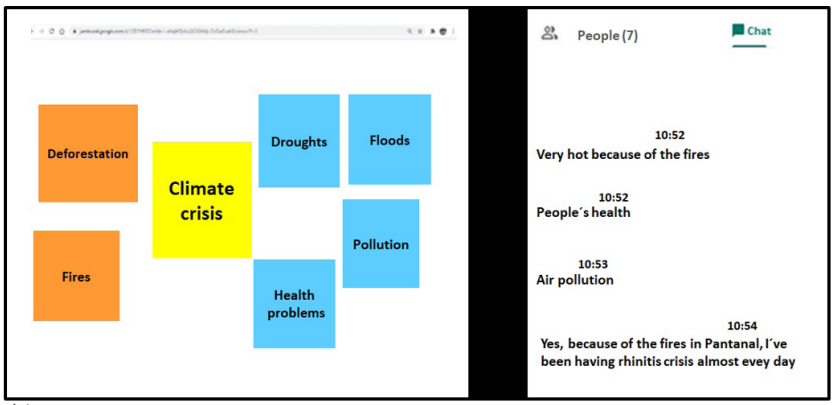


Source: Research data.

9- To know the complete results, see Souza (2021).

This activity allowed us to perceive a certain knowledge of students about both themes and notice that the tool could contribute to expressing their ideas in remote activities. We also saw that many students were comfortable participating using audio or the *chat* feature (Figure 3). This agrees with Qazi *et al.* (2020), who noticed that most students were familiar with the communication mediated by digital technologies.

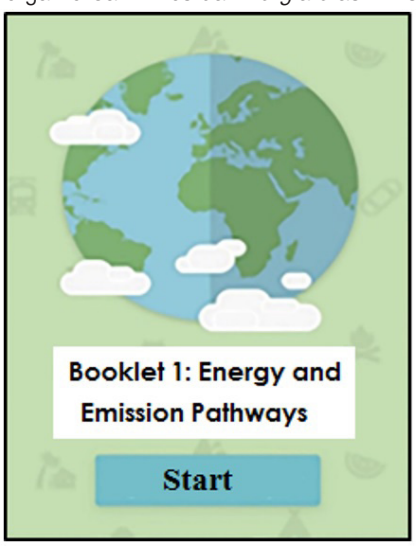
Figure 3 – Discussion, via *chat*, about the causes and consequences of the climate crisis



Source: Research data.

Another activity enacted during the course was the game *Caminhos da Energia e as Emissões* [Energy and Emission Pathways] (Figure 4), created based on the contents of the first booklet. This game was a challenge with questions and answers. To play it, the students received the booklet and, after, the link for the game and its working guidelines. The students were very receptive to the game.

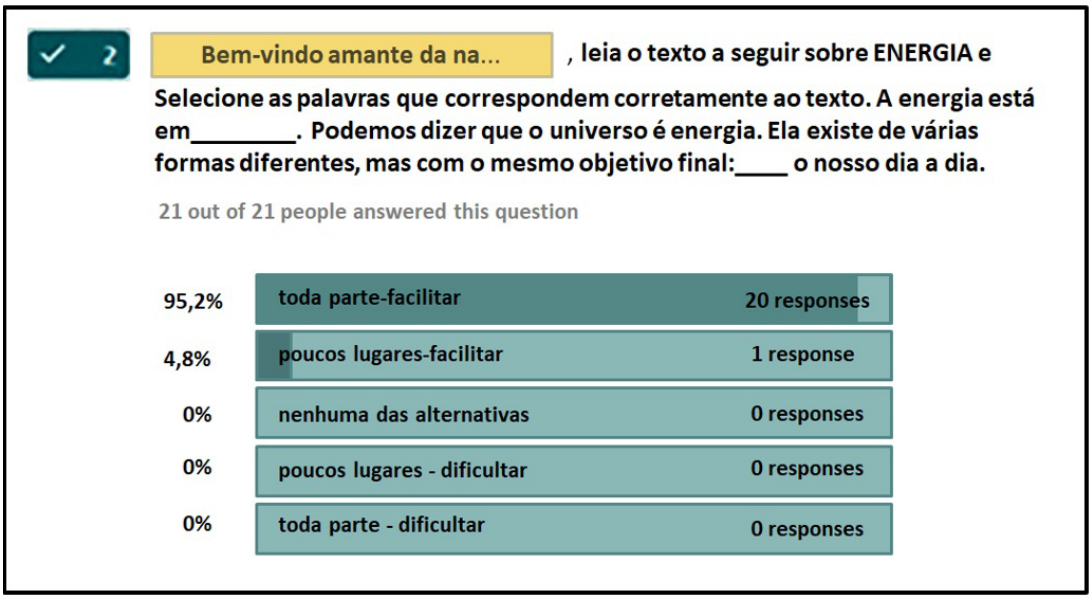
Figure 4 – Home screen of the game *Caminhos da Energia e as Emissões*



Source: Research data.

When analyzing students' answers in the fame, we can perceive some learning evidence regarding the approached contents. An example was the fourth question that asked them to identify which energy sources cited were the most recommended to decrease particulate material emissions and inadequate substances in the atmosphere. In this question, we saw that 95% of the participants answered correctly, showing that the themes developed in the first meeting and booklet were understood, as shown in Figure 5.

Figure 5 – Students' answers to the fourth question[10]

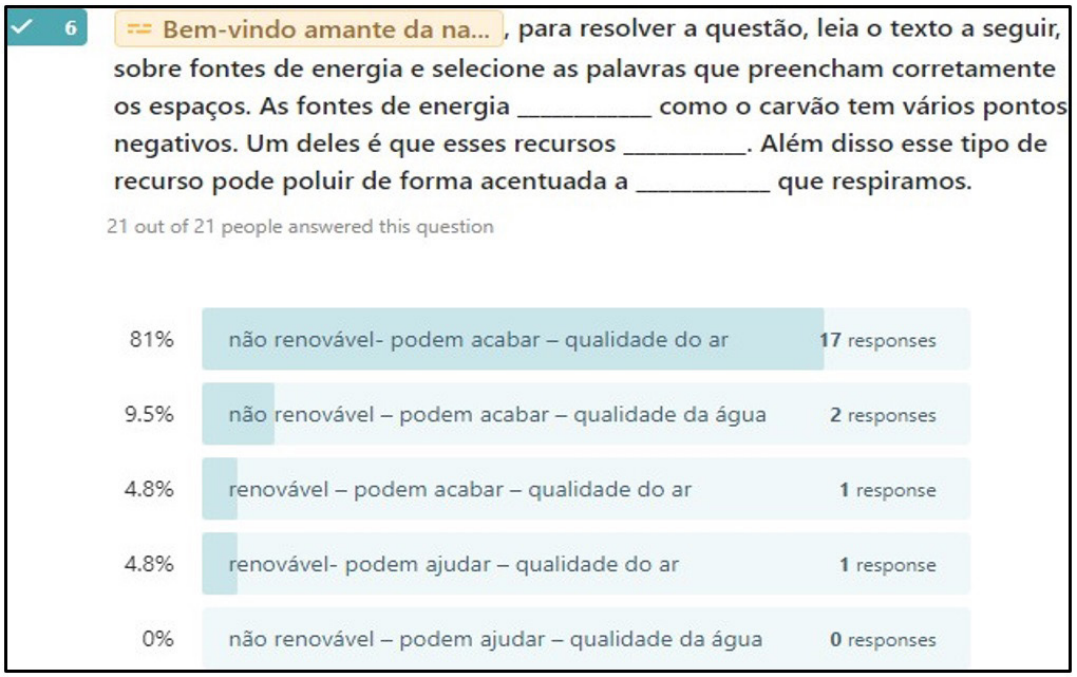


Source: Research data.

We observed one more example of learning based on the students' answers to the sixth question of the game, which approached renewable and non-renewable energy sources and their impacts. In this case, 81% answered it adequately (Figure 6).

10- Translation note: The phrase is: Energy is _____. We can say that the universe is energy. It exists in different ways but with the same final objective: ____ our everyday life. The options are: everywhere-facilitate/ few places-facilitate/none of the alternatives/few places-hinder/ everywhere-hinder.

Figure 6 – Students' answers to the sixth question[11]



Source: Research data.

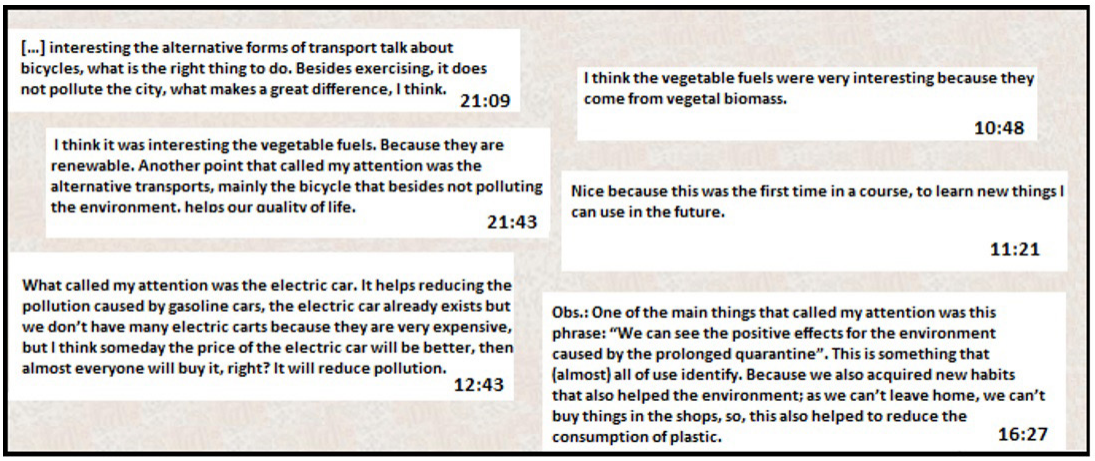
Other didactic resources involving digital technologies were used during the course, such as *Jamboard* and *chat*. The booklets are a resource typically used in initiatives to raise awareness of these different themes. As in the game case, these resources were well-received by some of the students, which are among the favorable aspects associated with using digital technologies indicated by Qazi (2020) and Stefaniak (2021).

However, it is noteworthy that the target-audience interest and the pandemic context motivated the option to use this type of technology. As Camargo (2020) reminds us, this context demanded the massive migration for remote ways of learning and, consequently, the adaptation of resources with pedagogical ends.

WhatsApp was also used as a didactic resource to exchange information, register comments about the course contents, etc. The approach was positive, as shown in Figure 7.

11- Translation note: The phrase is: The _____ energy sources, such as coal, have several negative points. One of them is that these resources can _____. Besides this, this type of resource can heavily pollute the _____ we breathe. The options are: non-renewable-end-air quality/non-renewable-end-water quality/renewable-end-air quality/non-renewable-help-water.

Figure 7 – Students' comments on *WhatsApp*

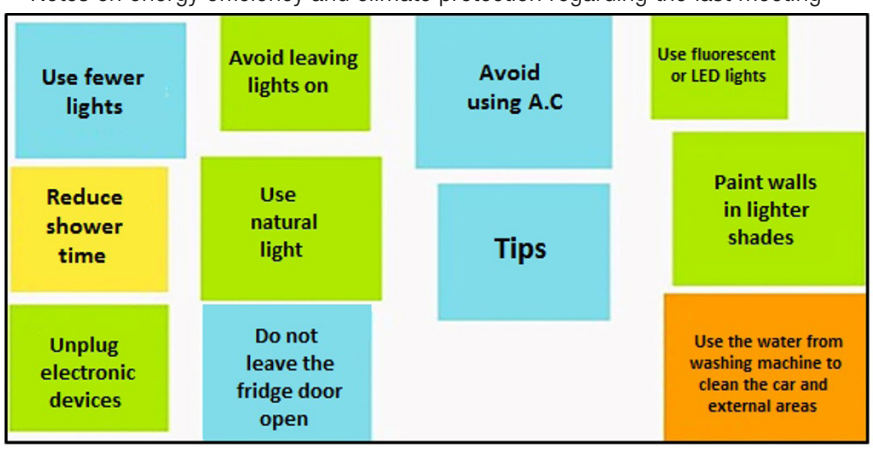


Source: Research data.

The students' messages in this application, which show possible evidence of learning the content approached, refer to the study of Pavão, Rocha, and Bernardi (2019). In this investigation, the authors indicate that various technological devices can be used for educational ends as long as their specificities are observed, and the activities planned in a way that can motivate and attract students' attention.

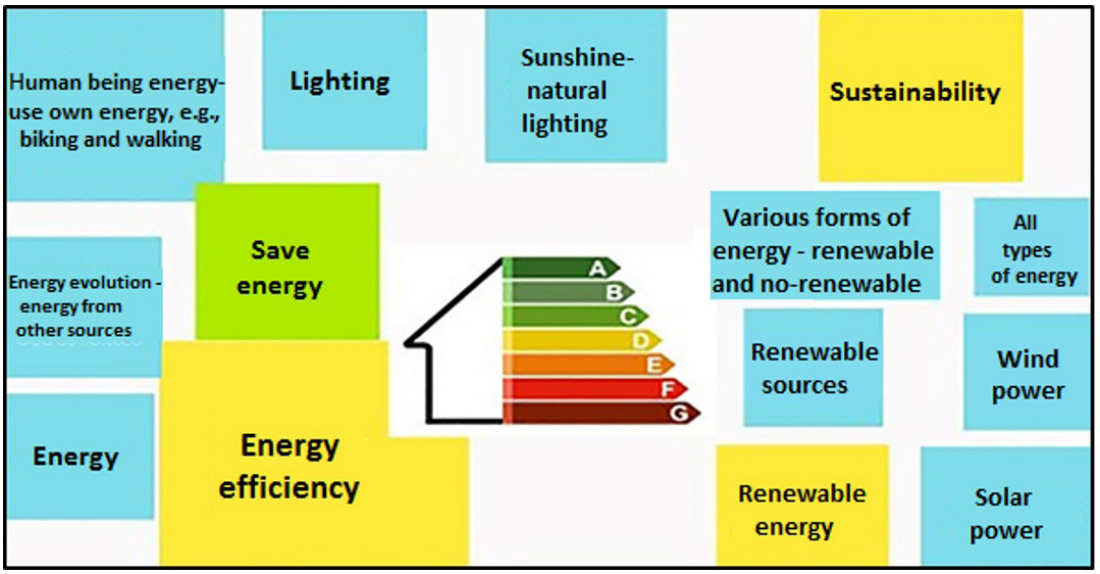
Finally, the results of the activities held in the last meeting stand out. On it, the students should comment orally or write in the *chat*, in the *Jamboard*, what they think about energy efficiency and climate protection and what issues were related to these themes after studying them in the short course. Besides this, they were asked to mention something that could be done to reduce the energy consumption in their houses or school. The answers can be seen in Figures 8 and 9, respectively.

Figure 8 – Notes on energy efficiency and climate protection regarding the last meeting



Source: Research data.

Figure 9 – Notes on what could be done to reduce energy consumption at home or school



Source: Research data.

We observed a significant difference when comparing the answers in the first meeting with those in the last. The students showed more knowledge of the theme studied after participating in initial problematization and organization activities. For example, this was evident when they related energy efficiency with renewable energies, natural lighting, and using body energy to move, as they indicated alternative transport ways, such as riding a bike or walking.

The themes of alternative transport and constructive strategies for rational energy use were developed throughout the course and were not cited by students when we raised their previous knowledge. Furthermore, this example shows that students could connect the themes studied with their everyday lives. We could identify evidence of learning in both cases.

Similarly, we observed learning evidence in students' answers when listing how to reduce energy consumption at home and school. Their answers included individual actions, such as reducing shower time and turning off lights, and constructive strategies, such as using natural ventilation or using light colors.

Based on these results, the short course can serve as an incentive for participant students to build a culture of rational use and saving of energy, which is pointed out in the National Plan of Energy Efficiency as imperative for contemporary times. This Plan also includes educational interventions among the strategies for its implementation (BRASIL, 2011).

Final remarks

This work proposed to evaluate the implementation of a university outreach initiative involving digital technologies, aiming to raise the awareness of elementary and middle school students between 10 and 13 years old, toward the rational use of energy and climate protection, held during the Covid-19 pandemic. Therefore, as a strategy to collect data, we implemented a remote short course, using *Google Sala de Aula* and its various resources throughout four meetings. In the first one, we developed an initial problematization. In the third and fourth, we organized the knowledge. In the fourth, we focused on knowledge application.

Based on the results of this research experience, the approach of the themes related to energy efficiency and climate protection can contribute to developing perceptions to decrease environmental impacts. In light of this, these themes must be part of the school curricula. For their development, one could use methodological strategies involving digital technologies, such as the one developed in this investigation, allowing the interaction of students, even if remotely, which can contribute to the socialization and exchange of experiences and knowledge. Furthermore, the technologies used for this end could consider the importance of contextualizing these themes, as in the course, as this can facilitate students' learning and favor the transmission of important knowledge to their families regarding each person's role in environmental protection.

Besides this, through the results obtained, it was possible to conclude that university outreach is an opportunity to approximate schools and academy in constructing methodologies that consider the teaching and learning of different subjects and, perhaps, the adoption of new habits, especially in the case of environmental education. Thus, it fulfills one of its essential roles, i.e., sharing knowledge pedagogically to be aggregated into citizens' lives. We also conclude that digital technologies are powerful tools for implementing outreach initiatives in pandemic contexts.

Finally, an important aspect to be highlighted is that students from different schools could offer the course simultaneously, as it was held remotely using digital technologies and despite contexts of sanitary insecurity. This is mainly relevant to potentialize building bridges between university and community, which is crucial nowadays.

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Ruana Tomaz de Souza is a master in Energy and Sustainability and a teacher in the State system of Santa Catarina.

Kátia Cilene Rodrigues Madruga is a doctor in Business Administration (Bremen/Germany) and an associated professor in the Department of Energy and Sustainability at the *Universidade Federal de Santa Catarina*.

Reginaldo Geremias is a doctor in Chemistry and an associated professor in the Department of Energy and Sustainability at the *Universidade Federal de Santa Catarina*.

Mônica Knöpker is a Doctor of Education and a professor in the Department of Teaching, Research and Outreach at the Instituto *Federal de Santa Catarina*.