University and local recyclable material cooperative – building bridges around e-waste

Abstract: An e-waste outreach project was developed with two overriding goals: (1) to strengthen the partnership between the university and the local recyclable material cooperative, which has been carrying out actions aimed at supporting the work of the Cooperative, and (2) to collaborate in the expansion of environmental education activities in the process of social and economic insertion of collectors and the reduction of environmental impacts. During this process, the materials and corresponding activities related to the theoretical and practical course followed by the cooperative workers were developed by a transversal team of (under)graduate students, faculty, and staff from the Chemistry, Electric Engineering, and Public Administration areas. In addition, social media materials were created to sensibilize and engage the university community regarding effective e-waste awareness, to adhere to the voluntary drop-off point of e-waste collection, and to address the issues that can affect our environment and health if e-waste is sent to landfills. It was an example of how chemistry contributes to the Sustainable Development Goals through an outreach project.

Keywords: e-waste; sustainability; cooperativism; outreach project; SDG #11

1 Introduction

The habits of contemporary societies collaborate with the large production of urban solid waste (MSW), with e-waste (electric and electronic waste) figuring as one of the largest and fastest-growing solid waste streams (Sengupta et al., 2023). Electronic waste has a special place regarding the emerging risk to the health of many populations when we consider the growing contamination of the environment, with the bioaccumulation of potentially toxic elements present in them (Song & Li, 2015), and the predictions regarding e-waste production are alarming. It is estimated that 74 metric tons (Mt.) of e-waste will be generated by 2030 and 243 Mt by 2050, according to the Global E-waste Monitor Report (2020) and Forti et al. (2020). However, what is impressive is the low rate of globally generated e-waste that is adequately recycled, less than 20 % (Sengupta et al., 2023). In most cases, especially in underdeveloped countries, e-waste is sent to landfills. The rest is sent to inappropriate units (dumps and uncontrolled landfills) and incinerated (Zulkernain et al., 2023). The failure in this process impacts landfills, reducing their useful life and the income of recyclable material collectors (Lima et al., 2022). In addition, e-waste management practices, such as dumping of e-waste in landfills and incineration, are unsustainable owing to the high risks of adverse effects on the environmental and human health (Dutta et al., 2023; Zulkernain et al., 2023). To make it worse, still nowadays, massive
amounts, 20–50 Mt, of e-waste are being transferred to poor countries apart from the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal that prohibits the exchange of hazardous waste between developed and developing countries (The Basel Convention Ban Amendment, 1995; Twagirayezu et al., 2023). On the one hand, e-waste could be seen as an opportunity for urban mining. Their metal part (around 30 %) could be used as a secondary source of critical raw materials (CRMs), such as Au, Ag, Cu, Pb, Pt, and other rare elements (Nd, In, and Ga) with estimated movement of more than 60 billions of USD in the global e-waste recycling industry, shifting the exploitation from natural stocks to anthropogenic resources (Xavier et al., 2023; Zulkernain et al., 2023). However, on the other hand, improper e-waste recycling practices can result in the generation of toxic gases, such as dioxin and furan (polychlorinated dibenzo-p-dioxins, and dibenzofurans (PCDD/Fs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), brominated flame retardants (BFRs), perfluoroalkyl and polyfluoroalkyl substances (PFASs), polychlorinated diphenyl ethers (PCDEs), and hazardous components comprising potentially toxic elements, such as lead (Pb), cadmium (Cd), chromium (Cr), mercury (Hg) etc. (Dutta et al., 2023). It is worth mention that these potentially toxic elements are often stated as “heavy metals” in the field of e-waste. This nomination is considered ambiguous and for that reason it is recommended to replace it with the term “potentially toxic elements” (Duffus, 2002; Pourret and Hursthouse, 2019).

Therefore, e-waste emerges as a challenging global environmental, social, economic, health, and legal issue of concern to be solved. This situation requires social responsibility and a commitment to sustainable development.

In this context, understanding that the role of the University in society goes beyond training students, generating, and sharing knowledge, but also setting an example of conduct to the community and promoting the democratization of knowledge, herein we present an outreach activity developed in partnership with the local cooperative of recyclable material collectors to implement the collection, segregation, and sale of electronic waste by the Acacia Cooperative. We envisioned a win-win relationship between the University and the local cooperative. The cooperative members win because there would be an increase in the volume and quality of the material collected at the University through the correct segregation of waste by the generators themselves, measured through the weekly weighing of the recyclable and e-waste destined to the recently created VDP (Voluntary Delivery Post). The university community wins from the point of view of citizenship and environmental responsibility as the whole university community is being stimulated to be actors in the more efficient selective collection of e-waste at the campus through their awareness and behavioral change. We hope that with the appropriation, use, and reproduction of the acquired knowledge, the cooperative members can increase their collection, aiming at reducing inequalities and social vulnerability, valuing the collectors, and overcoming environmental issues while the university community is more aware and active in its role as citizens. In doing so, this is a way to contribute to some of the Sustainable Development Goals (SDGs) proposed by the UN (United Nations) in the 2030 Agenda and the Chemistry Post 2022 Movement (Silva et al., 2022). The following headlines will describe the strategies used, the problems faced, and proposed solutions.

## 2 Outreach strategies and steps

The actions taken during this process are described below, as well as the problems involved and the results achieved during these actions.

### 2.1 Visit the cooperative of recyclable material collectors

From our experience, the dialogical approach is the top secret for successful activities and partnerships with local communities, especially the most vulnerable ones. That means the local community and university intrinsic knowledge are equally valued. In this way, we began by listening to the local community, and the activity was built based on their actual demands. The Acacia Cooperative, founded 20 years ago by a group of families living literally over the dumping ground, is the only cooperative of recyclable material collectors in the city of Araraquara in São Paulo State in Brazil and did not have a collection of e-waste in their portfolio. The cooperative
comprises 200 collectors, where about 90% of women are the head of the family and financially responsible for them. Their work is divided into four segments: selective collection of recyclable materials, sorting of them, processing of sorted material, and sale of processed material, as illustrated in Figure 1.

We learned from our brainstorming meeting with the cooperated team that they collected e-waste and stored it to sell it as scrap for meager prices, and, eventually, unknown people would come and ask to separate some parts of the e-waste, usually the motherboards. The wires were burned to recover copper. Their main issue in e-waste storage was related to robbery (sometimes even by cooperative members) by alcohol and drug addicts. At that time, they did not know the environmental and health issues they were exposed to, and we traced a plan of action to fill these gaps as they were willing to collect e-waste continuously.

2.2 Drive-thru within the campus for e-waste collection

To begin the theoretical and practical course with the cooperative, it was necessary to collect, quantify and categorize e-waste for the purpose of teaching them about best practices in handling e-waste. To gather this material and engage the university community, a drive-thru day was proposed to collect e-waste at the campus. The university team comprised students (grad and undergrad), technical staff, and professors from different areas (Chemistry, Social Sciences and Electric Engineering). While the students were responsible for the drive-thru promotion on social media and printing banners for signalization, the university staff oversaw traffic authorizations, balances for weighing the e-waste, containers to storage it and so on. The e-waste collection drive-thru took place from 10 a.m. to 1 p.m. at the main entrance of the Institute of Chemistry, resulting in 470 kg of e-waste, composed mainly of six desktop computers, eighteen laptop computers, eighty cellphones, eight printers, seven router boards, nine CD/DVD drives, nine tablets, six photographic cameras, seventeen computer boards and other items in smaller quantities such as mouses, speakers, headsets, and microphones (Figure 2).

2.3 Cooperative members' theoretical and hands-on training on how to work with e-waste

The preparation for the course was divided into developing a printed material (handout) with the content of the PowerPoint slides, a booklet to be used daily during the e-waste sorting, and buying toolkits to properly
and safely disassemble major components. Significant effort was made to use appropriate language in the technical materials. The goal was to make it simple and understandable for the collectors with deficient scholar backgrounds and, in some cases, almost functionally illiterate. All this material was developed under the guidance of our team’s electric and electronic waste specialist and responsible for the on-presence course.

From the cooperative part, they provided a locked area to store the e-waste they would deal with from now on (due to the robbery issues). This area was cleaned, adequately illuminated, and had a workbench and a set of 1500 kg bags to store the disabled e-waste.

The cooperative managers received the enrollment of 14 members interested in following the theoretical and practical course at the Acacia Cooperative plant. It was divided into two initial theory hours, 2 h of hands-on activity, and a coffee break (Figure 3). The entire course was filmed, and the edited file was made available for the Cooperative to revisit when necessary. The main goals of the short course were: (1) safety to avoid occupational accidents and the proper use of PPE (Personnel Protective Equipment) and screw toolkits, (2) recognition of the main parts of the electric and electronic waste, (3) hazardous substances encountered in e-waste and (4) pre-treatment techniques such as the mischaracterization of the e-waste and dismantling of specific components enough for sale. This physical separation consisted mainly of segregation into non-metal and metal classes before undergoing any further recycling process.

The participation of the cooperative team was massive in terms of doubts, questions, comments, and personal storytelling during the course. Some were disappointed because they thought they would do gold and platinum mining and have these pure materials at the end of the day. The lack of awareness regarding the harmful impacts of toxic components was impressive. However, they were willing to follow the recommendations and safety guidelines after the course. It’s worth mentioning that the correct guidance regarding the handling, separation, and disposal of e-waste is crucial because, as presented by Song and Li (2015), the routes of contamination can be by inhalation of harmful gases, ingestion, or skin contact, from their occupation, due to direct or indirect exposure, through air, soil, water or food.
2.4 Problems solved, deliverables and results achieved

Some deliverables achieved within this outreach program are cited in Table 1. One of the main reasons prohibiting people from proper e-waste disposal is the lack of e-waste recycling facilities in their vicinity (Varghese and Sharma, 2022). To circumvent this issue, a VDP (Voluntary Delivery Points) for e-waste was created at the Institute of Chemistry and adequacy of the storage of recyclable materials. Community adherence is being measured by constructing the historical series of the volume of recyclable material and e-waste generated and collected at the Institute of Chemistry. Therefore, these materials are weighted weekly. We believe that the university community better understands their role as consumers and is more prompt to become good stewards of the environment. Not only the community was impacted but our students’ team as well. Students’ testimonials such as “The project itself is essential and operates in areas forgotten by students and the Araraquara community. Flores initiatives generate curiosity and encourage their members to reflect on disposal.” And “I highlight fantastic learning experiences about concepts that permeate the field of sustainability.” Highlight the importance of outreach activities complementing their formal academic training and encourage them to be actors mitigating the e-waste crisis.

From the cooperative of recyclable material collectors’ perspective, the training of cooperative members in working with e-waste opened a new line of work within the cooperative. It took a year until the first results were seen. In baby steps, they organize themselves to carry out the collection of e-waste autonomously and deal with it safely. The main challenge regarding the realization of this project was to reach out to the cooperative leaders and establish a bond of trust so they were interested in joining the project. Unfortunately, we learned that they are sought after by universities for collaborations but seldom receive feedback from them. Too often, it is a one-way “partnership.” It is an alert that everyone should keep in mind when developing an outreach project.
Promoting this outreach activity in local TV news, radio programs, and newspapers in the city and region increased the visibility of the university, provided a means for society to understand and value the university’s role, and strengthened ties with the community. It was an excellent opportunity to reinforce the importance of science as a knowledge producer and convert it into employment and profits, contributing to socio-economic development.

3 Conclusions

Through this outreach program, we could understand the perception of the university community and contribute to raising their awareness about the damage e-waste causes to our environment and how essential it is to segregate and dispose of e-waste properly. In doing so, we believe they will act as knowledge multipliers, helping mitigate the e-waste crisis.

The strengthening of the partnership between the university and the local cooperative of recyclable material collectors collaborated in the expansion of environmental education activities, in the process of social and economic insertion of collectors, and the reduction of environmental impacts. It was an example of how chemistry contributes to the Sustainable Development Goals.

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References


Pourret, O., & Hursthouse, A. (2019). It’s time to replace the term “heavy metals” with “potentially toxic elements” when reporting environmental research. *International Journal of Environmental Research and Public Health*, 16(22), 4446.


