
The Role of Design Education in Electronic Waste Management

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ABSTRACT

Fast-changing technology is resulting in increased consumption of electronics. According to Nanath and Kumar (2019), the Global E-Waste Monitor 2020 reported that the amount of electronic waste produced in 2019 was 53.6 million metric tons. By 2030, they predict it to increase to 74Mt. This report also shows that, in 2019, the USA produced 6.92 million tons of electronic waste (e-waste), and only 15% was recycled. Severe environmental and human health problems will occur if the e-waste is not recycled appropriately. Unfortunately, the United States still needs a standard system for recycling electronic waste, including laptops, monitors, cell phones, printers, and television, which will lead to a low habit of recycling within the US population. The primary cause is the need for proper knowledge and awareness. One way to address the problem is to prepare the younger generation through education to create better habits and spread awareness of the importance of recycling electronic waste. This paper focuses on analyzing the existing quantitative and qualitative surveys on the role education methodologies have played in spreading this awareness of electronic waste recycling. Researchers are finding more about the most effective medium to communicate complex information about recycling and reusing electronic waste in students' courses. The curriculum should acknowledge how students can reuse electronic waste equipment rather than purchasing new devices. Additionally, gaps need to be addressed by the education system to build courses for students from all fields, as most of the existing studies specifically have electronic waste courses only for electrical or engineering students. This paper will propose an interdisciplinary approach to design education and electronic waste based on the existing literature and findings. The proposed approach will use design methodologies, such as divergent and convergent thinking, to educate students on electronic waste recycling and reuse. This will prepare the future generation to build the habit of recycling and reusing electronic waste and build a better environment.

Keywords: Design education, Interdisciplinary education, Electronic waste education, Design-driven e-waste education, Divergent, and convergent thinking, Electronic waste recycling, Sustainable design, Sustainable design education, Interdisciplinary education, Environmental education

INTRODUCTION

The Basel Action Network (BAN) defines electronic waste as “a wide and developing range of electronic appliances ranging from large household appliances, such as refrigerators, air-conditioners, cell phones, stereo systems,

and consumable electronic items to computers discarded by users” (Pariatamby, A et al., 2015). The recycling of electronic waste needs special handling and knowledge. It is crucial to note that many harmful chemicals, like lead and cadmium, and other hazardous materials, are present in the electronic items we use in our everyday lives. Moreover, electronic waste consists of metals and substances that produce harmful gasses, polluting air, water, and soil, which will cause severe environmental and human health problems (Saldaña & Messina, 2021). Additionally, the amount of electronic waste produced in 2019 was 53.6 million metric tons (Mt); by 2030, they predict it to increase to 74 Mt (Nanath & Kumar, 2021). Therefore, recycling e-waste properly and educating others to do the same is imperative. With the changing technology, there is an increase in the consumption of electronics, making it even more vital that we properly recycle electronic waste.

One way to address this problem is to prepare the younger generation to create a better practice of recycling electronic waste through education. Therefore, this paper will address how and what role design-driven education can play in spreading awareness of electronic waste recycling and reuse in different ways. It will also point out the gaps that need to be addressed by the education system so that the students can build the habit of electronic waste management. We need to spread awareness about the implications of how harmful electronic waste is. With the rapid increase in the production of electronic waste, it is our responsibility to build a society for the future generation where they can live in a better and clean environment. Therefore, institutions and policymakers must step forward to build an essential education system that addresses this issue. Because of all the above reasons, as already mentioned, educational institutions need to contribute more by introducing interdisciplinary courses and evaluating their effect on students’ habits.

More specifically, this study examines interdisciplinary courses as a potential solution to this problem. It examined a sample of educational institutions around the world that are already started adopting courses, research, and programs into the curriculum, which have yielded positive responses (Saldaña & Messina, 2021).

ROLE OF EDUCATION

To achieve a well-built curriculum, we must look at how to plan and teach an electronic waste recycling course effectively. Teaching the sustainability of electronic waste is very challenging as the topic is complex, and we can adopt an interdisciplinary approach to solve this issue. As previously mentioned, some institutions have adopted a few courses specifically for students with an engineering background.

One such course, provided by the Universidad Interamericana de Panama by the engineering faculty, was initially called “Development of a course based on BEAM robots to enhance STEM learning in electrical and mechanical domains (Lara *et al.*, 2022)”. Later, the course name changed to “BEAM Robotics: a sustainable and environmentally friendly technological approach (2022, p. 8)” after the program succeeded with positive results. The program

was a combination of developing engineering students' critical thinking using WEEE (Waste Electrical and Electronic Equipment). The students learn to reuse components instead of buying new equipment. In the course, modules 7 and 8 entirely concentrated on electronic waste and how the students could reuse electronic waste by dismantling a printer and removing components. After checking the working conditions of the disassembled parts, they were used to building their robots. The printers provided to the students were by the college itself (2022), which was an excellent way to reuse them as most colleges use many printers and store them after they reach end-of-life, which is harmful. The stored electrical components release toxic chemicals, which affect human health in the long run.

The other course was the electronic waste multilayer pilot program provided by the University of Illinois at Urbana-Champaign. This program not only had two courses about the recycling and reuse of electronic waste but also conducted a competition in which students from around the world participated, which helped to spread awareness not only to students within the university but also worldwide. The competition provided a platform for the students in the course to articulate and demonstrate their knowledge of electronic waste. In the course, through research, the students from the industrial department got to know that the state's regulations need to follow proper reuse and recycle procedures as it costs extra money and time (Bullock, 2011) that go into sending electronic waste to dynamics. This unit takes care of the proper recycling of electronic waste. Another drawback to reuse is that removing the hard disk from the equipment and replacing it with a new hard disk is mandatory. Some types of equipment, such as the iMacs, need additional technical skills to remove the hard disks. So the best alternative is to reuse other components in the electronic item and thus decrease the amount of electronic waste. They mainly synthesized these aspects in the course.

It is also essential to look at how we can affect students to build a habitual behavior change. We must dive deeper into understanding how to design the courses correctly. Mainly, we must consider the content of the course and the teaching methodologies (active learning, Etc.). It is equally important to consider the environment of teaching - in-person, synchronous, and asynchronous classes, as they considerably impact students' interest in learning. The syllabus I made contains in-person classes—designing the rest of the syllabus around an active learning strategy, readings, and a few videos. Krishnadas and Shivani did a study of video versus text (2021). They analyzed which mode is most effective for communicating the knowledge of recycling and reuse of electronic waste. It is crucial that it communicates the course's content, as it comprises complicated topics, and we need an interdisciplinary approach. Nanath and Kumar state in the article:

The communication mode for understanding human behaviour and raising awareness regarding e-waste could be through published articles or videos emphasizing and showing the damage it causes to the environment and society. Various participating organizations have taken up numerous initiatives to increase awareness and knowledge about the health hazards associated with e-waste. These initiatives include online guides for waste

disposal, a wide range of events and conferences for schools and universities, promotion in different recycling centers and shopping stores through pamphlets. Increasing awareness using more visual aids in communication might enable end-users to “see the unseen” and affect their attitude towards e-waste (Lange and Bishop, 2005). On the other hand, explicit written communication could leave a long-lasting effect on readers, consequently influencing management’s attitude towards e-waste.

There are two vital research questions addressed in this study. The first research question assesses the impact of awareness intervention on attitudes and actions related to e-waste practices. The second research question explores the importance of two communication formats (i.e. text and video) in influencing attitudes and actions related to e-waste practices:

RQ1. Is there a significant change in students’ behaviour and action when impactful e-waste awareness messages (both text and video) are shared with them?

RQ2. Is the behaviour and call for action different when e-waste awareness messages are shared in a text and a video format? (2021, p. 835)

The entire study used the same environment as the text and video content and conducted experimental research with two different groups. One group had only text and articles in their course, and the other had only videos. “This study confirms the effectiveness of communicating sustainability messages through texts and articles despite the existing literature claiming video communication to be more effective (Nanath & Kumar, 2021).” To summarize, the group most affected by the positive behavioral change had read the text. This result helps to understand the complexity of communicating the topic of sustainable reuse of electronic waste to students. It also points out how important it is for universities to take more initiative to make it an inclusive course. The researchers in the universities also have a crucial role to play to keep researching and spreading the importance of the topic, as education about electronic waste needs to be more explored and understood.

Design-driven education can fill the gap portrayed in the above courses. Literature shows they did many studies to include creative thinking in engineering and other curricula. Therefore, this will not only help to educate the students about electronic waste but also help them develop design thinking skills. Divergent and convergent thinking can play a crucial role in achieving this. Students need the knowledge to develop excellent and unique solutions to meet industrial standards where divergent thinking comes into the picture, where they develop as many unique solutions as possible for a problem—in this case, the reuse of electronic waste. Convergent thinking follows this, where students work on one suitable solution to build creative thinking and easily understand the complex subject of electronic waste with interest.

FUTURE SOLUTIONS

When analyzing electronic waste, knowledge of electronics is required to understand the components and uses. Secondly, harmful elements exposure comes under environmental studies. Lastly, to crack the understanding of developing interest in the subject, psychology, or any educational analysis.

I designed a syllabus structure with an interdisciplinary course of design thinking education in teaching recycling and reusing electronic waste.

With this said, we need to address many things so that the students become aware and make recycling a habit. Universities need to play a better role in spreading awareness by making it mandatory for students to have electronic waste recycling in their courses. The reuse and recycling of electronic waste is a complex topic, and different departments should join hands to form better courses. There are many ways to reuse, which can reduce the generation of electronic waste. These reuse methods can be an opportunity to build a habit in students. If the college raises enough funds, reusing old equipment, such as printers, CPUs, and many more that the university uses in their departments, can be reused after they reach the end of life. Refurbishing can also be an option. Students can do this as part of the curriculum, and thus students get hands-on knowledge on how to reuse the equipment rather than tossing it off. This (reusing equipment) can build a habit within the student's life, significantly impacting the long run. I can confidently say this as dad always tries to reuse as much equipment as possible in the house. He constantly removes parts from other equipment that are of no use and uses them on new ones when, for example, a mixer grinder stops working—fixing the mixer grinder with parts of old equipment. Dad has been doing this for many years, which helped me learn how to reuse. Similarly, students will slowly build the habit within the college and at their homes.

CONCLUSION

Getting access to knowledge of handling electronic waste recycling and reuse is critical as the harm it causes to the environment will lead to severe health issues. To avoid this, we need to act immediately. We can do this if the universities and educational institutes in a society spread access to knowledge, taking the first step to decimate the production of electronic waste. This direction can also help habituate students by reusing and recycling electronic waste with the proper knowledge. Leading to reducing the amount of electronic waste produced in society and helping build a better tomorrow.

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