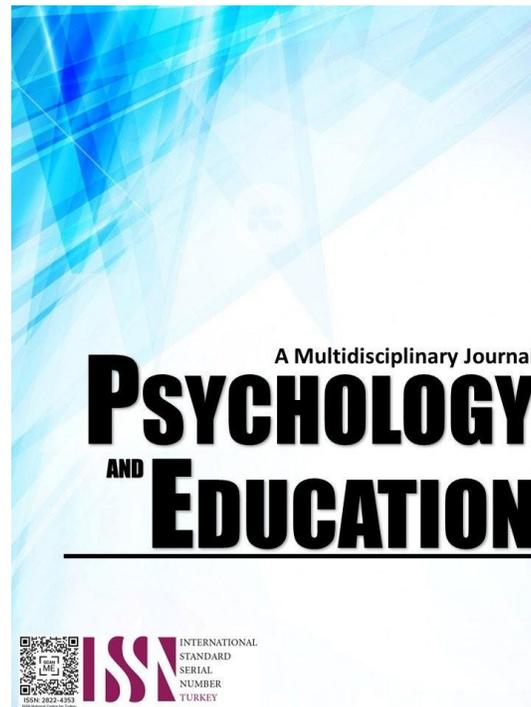


**A STUDY OF ENVIRONMENTAL AND ECONOMIC BENEFITS OF  
PAPER WASTE UPCYCLING TO CREATIVE PACKAGING  
PRODUCTS THROUGH A SEMINAR-TYPE AND  
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## A Study of Environmental and Economic Benefits of Paper Waste Upcycling to Creative Packaging Products through a Seminar-Type and Classroom Activities for Grade Six Learners of Kinabuhayan Elementary School, Dolores Quezon

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### Abstract

Educational institutions generate large volumes of paper waste, yet opportunities to transform this waste into creative and functional products are often overlooked. Upcycling discarded materials in a way that adds value offers a sustainable solution to environmental and economic challenges. This study aims to assess the environmental and economic benefits of paper waste upcycling through a seminar-type and classroom activity. Specifically, it investigates whether a structured educational intervention can increase the awareness of sustainability among Grade Six students, reduce paper waste, and promote the creation of creative packaging products. A mixed-methods approach was used, involving pre- and post-surveys and observation of 30 Grade Six students at Kinabuhayan Elementary School. The intervention consisted of a seminar on environmental sustainability, followed by a three-day classroom activity in which students upcycled waste paper into packaging materials. Data were analyzed quantitatively to assess changes in awareness and qualitatively to capture engagement and creativity. Findings revealed a significant improvement in students' understanding of environmental issues and the economic potential of upcycled products. Students demonstrated increased interest and participation in sustainability practices. The hands-on activity fostered creativity and resulted in usable packaging outputs. Additionally, the potential for cost savings and income generation through upcycled items was identified. Upcycling paper waste through educational interventions is effective in enhancing students' environmental awareness and promoting sustainable behaviors. It provides both ecological benefits and financial opportunities within the school context. The study suggests that integrating upcycling into the curriculum can empower students to adopt eco-friendly practices and support circular economy goals.

**Keywords:** *upcycling, paper waste, sustainability education, creative packaging, environmental awareness, economic benefits*

### Introduction

According to the World Counts, paper accounts for around 26% of total waste at landfills. From 2010 to 2060, the global consumption of pulp and paper is expected to double, the same as the amount of paper waste. An increase in paper production will also add further pressure to the world's forests, which are already in a critical state and are deteriorating. Between 2001 and 2019, a total of 386 million hectares of forest were lost globally across all forest types combined. This loss represents an almost 10 % decrease in tree cover since 2000. Polymeric waste-paper composites are a valuable cellulose-rich material from office paper, newspaper, and paper sludge. A systematic literature review found 75 publications over 27 years, with half published in the last five years, indicating an increasing interest in this field (Benini et al., 2023).

The word 'paper' was derived from the plant papyrus, which was used by Egyptians to produce the world's first crude writing material (Gaurav et al., 2019). Papermaking can be traced back to approximately AD 105, when Ts'ai Lun, an official attached to the Imperial court of China, created a sheet of paper using mulberry and other bast fibers, along with fishnets, old rags, and hemp waste. In its slow travel westward, the art of papermaking reached Samarkand, in Central Asia, in 751. In 793, the first paper was made in Baghdad during the time of Hārūn ar-Rashīd, with the golden age of Islāmic culture that brought papermaking to the frontiers of Europe. By the 14th century, several paper mills existed in Europe, particularly in Spain, Italy, France, and Germany. The invention of printing in the 1450s brought a vastly increased demand for paper. Through the 18th century, the papermaking process remained essentially unchanged, with linen and cotton rags furnishing the basic raw materials. Shortages increasingly plagued paper mills; in the 18th century, they even advertised and solicited publicly for rags. It was evident that a process for utilizing a more abundant material was needed. By using greater quantities of waste-paper stock, the need for virgin fibre is reduced, and the problem of solid waste is minimized. The expansion of this source is a highly complex problem, however, because of the difficulties in gathering waste-paper from scattered sources, sorting mixed papers, and recovering the fibre from many types of coated and treated papers. Waste-paper may be classified into four main categories: high-grade, old corrugated boxes, printed news, and mixed paper. High-grade and corrugated stocks originate mainly in mercantile and industrial establishments. White paper wastes accumulate in envelopes and printing plants, while ample offices supply tabulating cards. Much magazine stock comes from newsstand returns, but some comes from homes. Corrugated waste is supplied by manufacturing plants and retail stores. Printed news is derived from newsstand returns and home collections. Mixed paper comes from wastebaskets of office buildings and similar sources. In recent years, there has been considerable interest in recycling waste paper for environmental reasons (Britt, K., 2020).

Paper can be classified into the following categories based on numerous parameters. Based on the grade: Firstly, processed paper from raw wood pulp is called a virgin paper or virgin grade paper. Based on the smoothness and treatment given to pulp and paper, it is broadly divided into two categories: Paper used for printing, labelling, writing, books, etc. are made of bleached pulp and called as fine paper, and paper used in packaging of food materials which is made of unbleached pulp are called a coarse paper (Gaurav et al., 2019). Cellulose, a natural polymer extracted mainly from Pinus or Eucalyptus, is the raw material for paper production. Paper is widely used in various products and purposes, such as printing, copying, packaging, and hygiene. Once used, waste papers, mainly office paper (from printers, photocopiers, or drafts), old newspapers, and sludge paper (a byproduct of paper production), can become fuel sources destined for landfills or recycling. However, an enormous amount of waste paper is underused or inappropriately discarded. Approximately 40.3% of this paper is consumed, leading to global environmental problems. Therefore, over the last 100 years, several studies have sought alternatives to increase the reuse or recycling of waste paper (Benini et al., 2023).

Packaging is a container, wrapper, or container in which the substance or product in the product line is placed. It is covered or wrapped with a material that protects the content and environment of the product, facilitates its transportation, storage, sale, use, can be partially or wholly disposed of in the future or recycled (Barutcu & Gokkaya, 2023), defines it as covering or combining with the product, which integrates with the product and expresses the product it contains in the best way, thus affecting the functions of marketing, providing convenience to consumers both functionally and aesthetically, and when cleverly designed, it can also be used in the promotional activities of businesses.

Waste paper management in an educational institution can be considered a practical solution for improving the sustainability of the environment. Sustainable waste management is a challenge for the Municipal Corporation. Developing countries are faced with problems of Sustainable Waste Paper Management (SWPM). WPM faces challenges of a financial, cultural, social, and technological nature. Burning uncontrolled disposal of paper is caused by CO, CO<sub>2</sub>, SO, NO, and other emissions that directly affect the environment (Bhusan et al., 2019). It was hard to deal with the waste in a pleasant way (Moscato et al., 2020). In particular, uncontrolled waste disposal, the release of toxic substances, and the illegal burning of waste all lead to a high number of health problems, such as cancer deaths and congenital disabilities, and a less-than-satisfactory quality of life in general (Alaanuloluwa Ikhoso, 2018). One solution could be to offer ways to get rid of trash other than putting it in a landfill or burning it (Kachelmeier & Svihla, 2020).

Reuse and upcycling were standard practices for thousands of years before the Industrial Revolution and are still common in developing countries for financial reasons (Cooper et al., 2014). The term upcycling was coined by Braungart and McDonough (2010) in their book on ecologically intelligent design, *Cradle to Cradle: Remaking the way we make things*. Upcycling is related to the 'greener living' phenomenon, featuring the repurposing of things formerly known as garbage. The mindset of 'cradle to cradle' has seemed to catch fire outside activist communities and eco-friendly movements. Despite the increasingly visible emerging practitioner, with growing resources (e.g., workshops, website), the upcycling practice is still marginal. Taking into account the potential of product upcycling as a means towards waste prevention and sustainable production and consumption, the most relevant question to ask at this point, from the perspective of sustainable design, may be how to scale up this marginal practice into a mainstream practice to make a bigger impact on society and the environment. A logical solution to create a meaningful level of scaling-up would be to generate effective strategies and tactics for change, which requires understanding what drives and facilitates upcycling (i.e., its determinants). In this respect, there appears to be a notable lack of publications addressing the determinants of upcycling. This paper reviews relevant contemporary literature and presents the drivers and facilitators identified accordingly (Cooper et al., 2014).

Within the context of the upcycling concept, Gu and Xu (2015) propose five guiding principles for waste product redesign as follows:

#### *Enhancing the overall value*

Because the primary objective of upcycling is to raise the value of waste and transform it into a source of wealth, increasing that value should come first in the process. In order to adhere to such a guideline, designers are obligated to thoroughly investigate the potential worth of the waste in terms of its function, material, structure, and so on, and to do all in their power to increase that value.

#### *Reprocessing as much of the waste as possible*

To maximize the use of waste and minimize secondary waste, redesigning with waste as the raw material should involve making every effort to reduce the amount of waste generated throughout the production process. In order to make a suitable program for the entire design and manufacturing process, which requires the designers to start from the source, as well as be well-equipped with sound control ability to deal with emergencies, the designers must start from the source. However, not all types of waste can maximize their potential applications in the same way. Because of this, the designers need to have a certain level of environmental awareness in order to identify how to minimize production and ensure the appropriate treatment of waste to the greatest extent possible.

#### *Being ecologically friendly*

Even while the raw material for redesigning products originates from things that have been used up or thrown away, this does not mean that the quality of such products is poor. On the other hand, the designers ought to treat it similarly without prejudice and develop it with the same status as typical products in order to guarantee that its quality is long-lasting and to extend the amount of time that it can be used. When it comes to the design, use, and recycling of products, negative impacts on the environment should be avoided at all

costs. In the meantime, product designers should focus more on taking environmentally friendly products as a design guide and avoid the use of materials that are harmful to the environment.

#### *Keeping a close eye on the expenses*

Although upcycling and redesigning waste should be subject to effective cost management, this will not happen if products cannot be adequately converted into other usable products, which will result in a significant drop in value. Therefore, the first step of the regeneration process is the design. In this step, designers must consider all aspects of the design process to effectively control the cost of redesigning from the source.

#### *Maintaining the aesthetic of the populace*

The design principle of using commercialization as a guide should be followed by the principle of conforming to the aesthetic taste of the general audience. In accordance with this idea, the designers should have excellent visual quality, an acute understanding of, and be familiar with the conditions and customs of the target market, in addition to having sensitivity regarding features that are fashionable and popular. Moreover, they do their best to avoid incorporating their own personal views and values into the design so that the end product can be considered an individual "thing" that does not adhere to the aesthetic preferences of the general audience.

The product design is mainly relevant and responsible for school product waste because many of these products end up in the trash. In order to achieve zero waste by design, products and packaging must never end up in a landfill. The main objective of cradle-to-grave production is to create products that can be used and reused throughout their entire lives in ways that add value (Wilber, 2010). The way design is executed falls short of this objective. There must be a dramatic change in how things are conceived, built, packaged, distributed, repaired, recycled, and disposed of at the end of their life. This cannot be accomplished without a radical rethinking of product design, construction, materials, performance characteristics, and end-of-life considerations (Boonpracha et al., 2024). Design professionals and manufacturers need to think about how they might effectively enable upcoming extended product responsibility and product stewardship rules, in addition to the more obvious problems with landfills. It has been proven that product take-back for reuse has the potential to be profitable and even save much money compared to purchasing new products (Klausner et al., 1998), and it has been suggested that product reusing is a better price for product design than recycling (Boonpracha et al., 2024). Reducing carbon emissions and waste, utilizing, and reusing materials responsibly, and limiting energy expenditure in production cycles are all aspects of the Reduce, Reuse, Recycle, Remove movement that can be helped by designing with component reuse as a primary priority energy expenditure in production cycles. At the World Economic Forum in Davos in January 2016, the circular economy was a central topic. It is argued that there are potentially significant economic benefits for industrial systems in organizing for the reuse of raw materials and components in circular systems.

Upcycling is a process that transforms waste materials, like used paper, into new and valuable products. At Kinabuhayan Elementary School, upcycling paper waste could involve turning old notebooks, worksheets, or other discarded paper into items like recycled notebooks, handmade cards, or art projects. This approach not only reduces the amount of paper thrown away but also gives the paper a new purpose. By teaching students and staff how to upcycle, the school can encourage creativity and resourcefulness. It also helps the environment by lowering the need for new paper, saving trees, and reducing pollution. Through upcycling, the school can create a culture of sustainability, where waste is seen not as something to discard, but as a valuable resource to be reused in creative ways.

Scientists, in the early 70s, stated that serious dangers would be inevitable in the next hundred years if the increases in world population, industrialization, pollution, food production, and resource depletion were continued (Bridgens et al., 2018). Climate change, acidification, smoke, toxins, waste, and resource depletion, which are the consequences of industrialization, are the focal points of the hazards. Over the years, it has become more important to minimize all these environmental effects and to create a clean and livable environment (Ferrara, 2019).

In 2020, 59.7% of the total amount of paper consumed worldwide was recycled, with the highest rates in Europe (73.3%) and North America (68%). Moreover, waste paper is considered the most recycled packaging in Europe (82%), followed by metals (77.4%), glass (75.4%), and plastic (40.6%) (Benini et al., 2023). Despite a high recycling rate of ca. 60% in the Northern countries, paper and paperboard waste still represent a substantial number of total landfills, ca. 15% in the United States and roughly 18% in the European Union. At the same time, the growing worldwide demand for end-use products is depleting natural resources at an alarming pace. The cultivation of natural products has started to lag behind their consumption. Paper and paperboard represent almost 30% of the total generated municipal solid waste, and the per-capita consumption of cellulosic products is predicted to rise from currently 3.7 to 5.4 kg in 2030 (Harlin et al., 2015). The European Union's priority within the scope of reducing waste pollution and protecting the natural environment is to prevent the production of packaging waste. Some additional key principles support this priority. These are packaging reuse, recycling, and other forms of packaging waste recovery, and ultimately the eventual elimination of such waste (Barutcu & Gokkaya, 2023).

One of the researchers of the research (Boonpracha et al., 2024) is to study further the other potential of waste materials for upcycling and reusing not created for soft drink cans. Moreover, there is a growing recognition that other types of waste, like paper, also hold significant potential for upcycling. Their studies suggested that it is important to explore the possibilities of upcycling materials beyond just cans to understand the scope and impact of this practice entirely. To confirm this idea and to broaden our understanding, more



research is urgently needed to investigate how different types of waste, including paper, can be effectively upcycled. This research could help in developing more comprehensive and sustainable waste management strategies.

Our world faces significant challenges in achieving sustainable development due to the scarcity of natural resources and the environmental impacts of all human activities. The 2030 Agenda for Sustainable Development consists of a plan guided by 17 sustainable development goals (SDGs) to improve people's lives now and in the future in a global partnership. SDG number 12 (responsible consumption and production) aims to achieve sustainable development through changes in consumption and production patterns through the efficient management of natural resources and changes in waste disposal through prevention, reduction, recycling, and reuse (Benini et al., 2023).

According to the research of Aakjaer & Wegener (2016, who define sustainability along the three integrated dimensions: economic, social, and environmental. Upcycling for sustainability is hence not just a design approach. It is a mindset and a practice concerned with the lifecycle of things, emergent organizational forms, and mutual efforts for the changes across social groups. An upcycled object or process has improved eco-credentials, but it is primarily the story of rehabilitation and the visible processes of re-valuing waste instead of throwing it away. As stated in the introductory motto, there is no 'away', as permanent disposal is an illusion. Waste 'strikes back': despite costly destruction, it does not simply disappear, but generates polluted environments and health hazards. An alternative to this 'getting rid of' mentality is the story of rehabilitation. This story can take various forms, but at its core is the idea of sustainable consumption, which is highly relevant to social innovation, as it raises a voice against the uncritical production of waste and the devaluation of human rights. What makes upcycling distinct from other kinds of social innovation is the incorporation of the transformation process. Upcycled products and processes, telling stories such as 'production with zero waste', 'small is beautiful', and 'start local, but think global' (Aakjaer & Wegener, 2016).

Sustainability was expressed as sustainable development in conjunction with the term development in the Brundtland Report titled "Our Common Future," prepared by the United Nations World Commission on Environment and Development in 1987. In the report, sustainable development is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. This definition states that current economic development will not make the economic situation of future generations worse than it is today (Barutcu & Gokkaya, 2023). Further definition was supported on another presentation and exposition by Holden et. al (2014) on Sustainable Development: Our Common Future Revisited. This article reassesses the 1987 definition and principles of sustainable development, examining its evolution and critique over the ensuing decades. The authors analyze the broad application of the concept across policy and governance and caution that, though universally accepted, it risks becoming diluted without clear, measurable metrics.

Sustainable packaging is an idea that needs to be addressed with a systemic approach. SPA first defined the four principles of sustainable packaging under the headings of "effective", "efficient", "cyclic", and "safe". These are phrased with terms such as "reduces product waste" and "improves functionality" to highlight the fact that sustainability is a continuous improvement process rather than a predetermined endpoint (Lewis et al., 2007).

Table 1. Definition of Sustainable Packaging by SPA (Sustainable Packaging Alliance)

Principles	Explanation	Applied Level
Effective	Adds real value to society by supporting conscious and responsible consumption and by effectively protecting and containing products in the supply chain.	Society
Efficient	Packaging systems are designed to use materials and energy as efficiently as possible throughout the product's lifecycle.	Packaging System
Cyclic	Packaging materials are constantly translated into natural and technical systems through material reduction and additive development.	Packaging Material
Safe	Packaging parts do not pose a risk to human health and the ecosystem.	Packing Parts

Source: (Barutcu & Gokkaya, 2023).

Considering the product life cycle, green consumers also do not want the product and packaging to become waste, and some sensitive consumers and companies can offer alternative solutions and creative works. This concept, which also contributes to reducing waste by prolonging product life, is known as upcycling. It is important to evaluate upcycling both on an industry basis and on an individual consumer basis (Barutcu & Gokkaya, 2023).

In upcycling, waste materials could be used for something else, as long as they fit with their nature and structure. This would be easier to do if the process also gave something extra, like designing products that look great and are in style. In fact, the market tends to associate things made from waste or upcycled materials with a "corrupted" image. Design can respond to this idea by generating new ideas and perspectives through innovative objects and products (Kachelmeier & Svihla, 2020).

The study will examine the potential waste materials for packaging upcycling, and discover paper waste as a promising option that could bring both environmental and economic benefits to Sta. Lucia National High School. Unlike some other materials, paper waste is abundant in schools, making it an accessible resource for upcycling projects, such as packaging products. By repurposing paper waste, the school can reduce its environmental footprint by reducing the amount of waste sent to landfills. Additionally, upcycling paper waste into creative packaging products could save money by reducing the need for new packaging materials and potentially

generating income through the sale of upcycled items. This approach not only supports sustainability but also contributes to the students' financial well-being.

## Research Objectives

Despite the increasing global focus on sustainability, paper waste management in educational institutions like Kinabuhayan Elementary School in Dolores, Quezon, remains inefficient, contributing to environmental degradation and missed opportunities for resource recovery. While paper waste is one of the most abundant and easily recyclable materials, its potential for upcycling into valuable products such as creative packaging is underutilized. Furthermore, there is a gap in students' awareness about upcycling and its potential to address both environmental and economic concerns.

This study aimed to fill this gap by exploring the environmental and economic benefits of converting paper waste into creative packaging products through a seminar-type activity for Grade Seven learners. Specifically, the research investigated how upcycling can significantly reduce paper waste, lower the school's environmental footprint, and generate economic value by reducing material costs and possibly creating revenue through upcycled products.

The study also examined the educational impact of engaging students in sustainability practices, aiming to foster a culture of environmental responsibility and innovation. By addressing both the environmental and economic implications of paper waste upcycling, this research provided valuable insights into sustainable waste management solutions that can be implemented in schools and beyond.

By the end of the study, this research aimed to answer the following seven specific questions:

1. Do students use more than five sheets of paper per day at school?
2. Are students interested in learning about ways to upcycle paper waste?
3. Are students aware of how upcycling paper waste can benefit the environment?
4. Does participating in a seminar on upcycling increase students' awareness of environmental benefits?
5. Do students believe that upcycled paper products can be as valuable and be used as an alternative to new paper products?
6. Is upcycling paper waste seen as a valuable method for reducing waste and helping the environment among students?
7. Do students think that upcycling paper waste into packaging products could save money compared to using new materials?

## Methodology

### Research Design

This study employed a mixed-methods research design, integrating both quantitative and qualitative approaches to gain a comprehensive understanding of the topic. The quantitative aspect included the use of pre-test and post-test surveys to measure changes in students' knowledge and perceptions before and after the seminar on paper waste upcycling. These surveys aimed to gather numerical data that could be analyzed statistically. The qualitative aspect of the study focused on observations during the project workshops, where students created upcycled packaging products from paper waste. These observations provided deeper insights into how students applied what they learned during the seminar in a practical, hands-on setting. By combining both methods, the study sought to understand not only the statistical impact of the seminar on students' knowledge but also their experiences and engagement with the upcycling process.

### Respondents

The respondents of this study were the Grade Six students of Kinabuhayan Elementary School. There were 30 students in this grade, and all of them were involved in the study. The researchers chose the entire Grade Six population to ensure that every student's perspective was considered and because the number of students was small enough for the research to be manageable.

### Instrument

The tools and instruments used for data collection in this study included a survey questionnaire and an observation checklist. Each instrument was carefully developed to gather specific data related to students' knowledge, attitudes, and behavior regarding paper upcycling. These instruments were designed to be both valid and reliable, ensuring that the data collected accurately reflected the students' experiences and perceptions.

### Procedure

Data were collected using two methods: surveys and observations. The surveys were administered to the students at two points: before the seminar to assess their initial knowledge, and after the seminar to evaluate any changes in their understanding and perceptions. These surveys were chosen because they provided measurable, quantifiable data that could be easily analyzed to determine if the seminar had an impact on students' knowledge and attitudes about paper upcycling. The observation method took place during the students' project workshop, which was held over three consecutive days from 2:00 PM to 3:00 PM. The researcher observed how students engaged with the activity, how they worked together, and how they applied the concepts of sustainability that were taught

during the seminar. Observations were particularly valuable because they allowed the researcher to capture real-time behaviors and interactions, providing insights into how students internalized and applied what they had learned.

### Data Analysis

The data collected from the pre-test and post-test surveys were analyzed using descriptive statistics, such as frequencies, percentages, and means, to summarize the students' responses. A paired t-test was used to assess whether there was a statistically significant difference in students' responses before and after the seminar. This helped determine if the seminar led to any changes in students' knowledge and perceptions about paper upcycling. For the qualitative data collected from the observations, thematic analysis was used. This process involved identifying recurring themes or patterns in students' behaviors and interactions during the project workshop, such as engagement, creativity, and the application of environmental and economic sustainability principles. The researcher categorized these observations to understand how students applied their knowledge of upcycling in a practical setting.

### Ethical Considerations

The study adhered to ethical guidelines to ensure the rights and privacy of the students. First, students were informed about the purpose of the study, the methods of data collection, and their rights, including the right to withdraw from the study at any time without penalty. Confidentiality was maintained by anonymizing all survey responses and observation data. No personal identifiers were included in the data analysis or report, ensuring that the identities of the students were kept private. Additionally, school approval was sought to ensure that the study complied with the school's guidelines and policies.

### Results and Discussion

This section presents the results and findings from the data gathered through survey questionnaires and observations conducted during the study. It includes the interpretation of data collected during the pre-test and post-test stages, along with insights from the observation checklist. The section highlights the responses for each survey question, comparing pre-test and post-test results, and provides a detailed analysis of the findings. The data are further analyzed using statistical methods, such as the t-test, to determine whether any significant differences exist in students' perceptions and awareness regarding the environmental and economic benefits of paper upcycling.

### Survey Results

The following section presents the analysis and interpretation of the pre-test and post-test responses based on the survey data collected.

Table 1. Gathered data for question number 1, usage of paper (more than 5 sheets)

Response Category	Pre-test (Actual Data)	Pre-test (Percentage)	Post-test (Actual Data)	Post-test (Percentage)
Absolutely Disagree	5	17.2%	0	0%
Disagree	2	6.9%	4	13.8%
Agree	12	41.1%	12	41.4%
Absolutely Agree	10	34.5%	12	41.4%

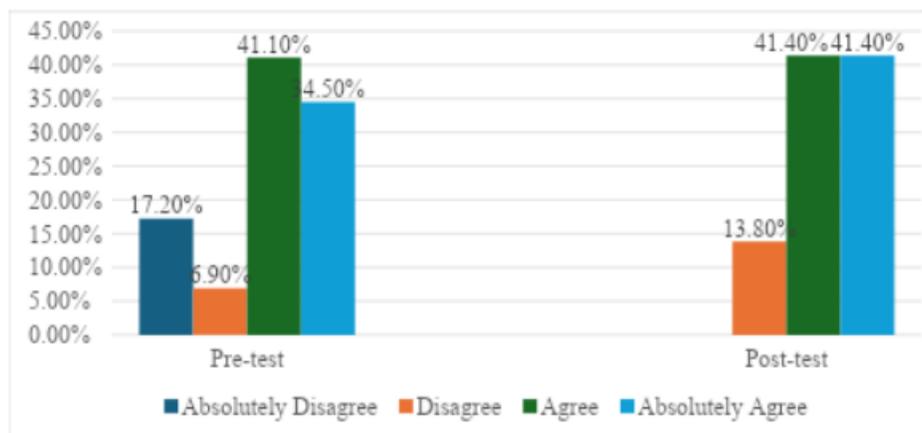


Figure 1. Proportion of data for the level of paper usage

In the pre-test, 75.9% of respondents agreed or strongly agreed that they used more than five sheets of paper, while in the post-test, this figure increased to 82.8%. A notable change was seen in the "Absolutely Disagree" category, where 17.2% of respondents strongly disagreed in the pre-test, but this dropped to 0% in the post-test. Additionally, the percentage of respondents who strongly agreed increased from 34.5% in the pre-test to 41.4% in the post-test.

This suggests that, over the course of the study, there was a greater awareness of paper usage, and more students recognized their paper consumption habits, especially in terms of using more than five sheets of paper.

Table 2. Gathered data for question number 2: usage of paper for non-academic purposes

Response Category	Pre-test (Actual Data)	Pre-test (Percentage)	Post-test (Actual Data)	Post-test (Percentage)
Absolutely Disagree	3	10.3%	3	10.3%
Disagree	11	37.9%	6	20.7%
Agree	11	37.9%	12	41.4%
Absolutely Agree	4	13.8%	7	24.1%

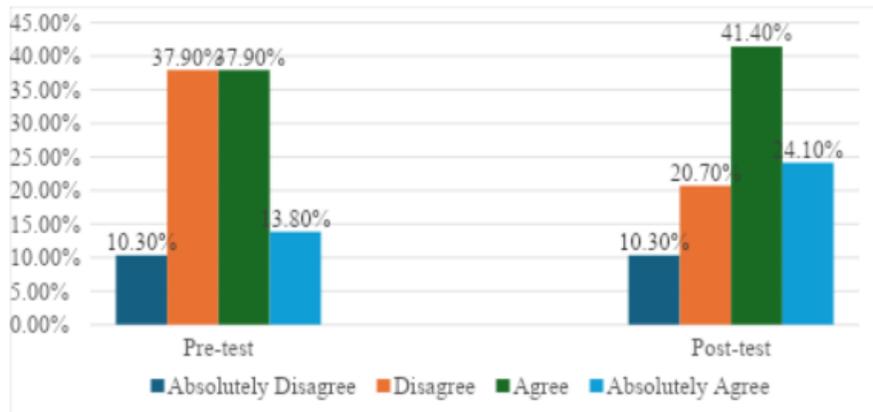


Figure 2. Proportion of Data for Paper Usage for Non-Academic Purposes

In the pre-test, 51.7% of respondents agreed or absolutely agreed that they used paper for non-academic purposes, while in the post-test, this figure increased to 65.5%. The "Absolutely Disagree" category remained the same at 10.3% for both pre-test and post-test. However, a decrease was observed in the "Disagree" category, dropping from 37.9% in the pre-test to 20.7% in the post-test. The percentage of respondents who agreed with using paper for non-academic purposes increased from 37.9% in the pre-test to 41.4%, and those who absolutely agreed increased from 13.8% to 24.1%. This suggests that, after the intervention, students showed more recognition of using paper for non-academic activities, indicating a shift in their awareness and usage patterns.

Table 3. Gathered data for question number 3, the importance of learning ways to reduce paper waste

Response Category	Pre-test (Actual Data)	Pre-test (Percentage)	Post-test (Actual Data)	Post-test (Percentage)
Absolutely Disagree	2	6.9%	0	0%
Disagree	3	10.3%	1	3.4%
Agree	12	41.4%	20	68.9%
Absolutely Agree	12	41.4%	7	24.1%

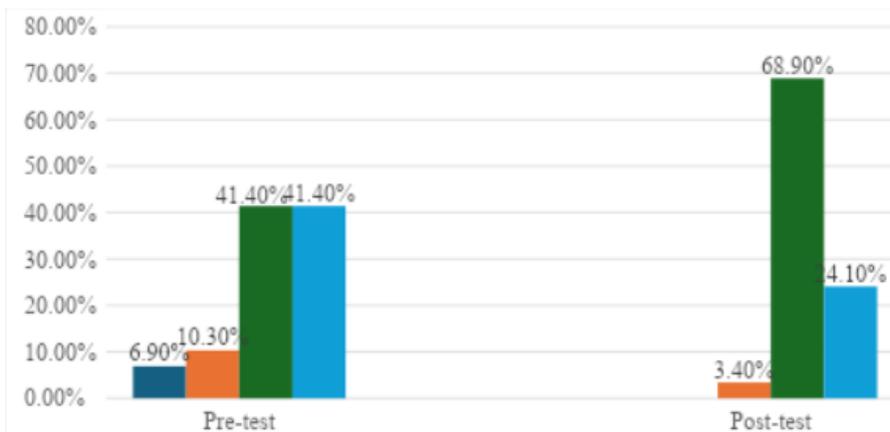


Figure 3. Proportion of data for importance of reducing paper waste.

In the pre-test, 82.8% of respondents agreed or absolutely agreed that learning ways to reduce paper waste was important. In the post-test, this figure increased to 93.1%. The "Absolutely Disagree" category decreased from 6.9% in the pre-test to 0% in the post-test, indicating a significant shift in students' attitudes towards the importance of reducing paper waste. The "Disagree" category also saw a reduction, dropping from 10.3% in the pre-test to 3.4% in the post-test. Additionally, the percentage of respondents who agreed or

absolutely agreed with the importance of learning to reduce paper waste increased significantly, suggesting that students became more aware of the importance of this issue after the intervention.

Table 4. *Perceptions of the Importance of Paper Upcycling in Reducing Pollution and Preserving Natural Resources*

Paper Upcycling	x	Pretest	0.739595	t-Test: Two-Sample Assuming Unequal Variances		Pretest	Post	
Absolutely Agree	4	6	24			4	4	
Agree	3	16	48		Variable 1	4	4	
Disagree	2	4	8	Mean	3.035714286	2.862068966	4	4
Absolutely Disagree	1	3	3	Variance	0.406084656	0.766009852	4	4
		29		Observations		29	4	4
Paper Upcycling	x	Post test	0.391582	Hypothesized Mean Diff	0.173645		4	4
Absolutely Agree	4	6	24	df	51		3	3
Agree	3	17	51	t Stat	1.58294E-06	<b>0.00000158</b>	3	3
Disagree	2	5	10	P(T<=t) one-tail	0.499999372		3	3
Absolutely Disagree	1	0	0	t Critical one-tail	1.67528495		3	3
		28		P(T<=t) two-tail	0.999998743		3	3
				t Critical two-tail	2.00758377		3	3
Pretest	2.862069			Ho: There is NO significant difference in the students' perceptions on the importance of paper upcycling in reducing pollution and preserving natural resources.			3	3
Post test	3.035714			Decision:			3	3
Difference	0.173645			Decision: Since t stat ( 0.000001582) is less than t crit (2.0075), there no enough statistical evidence to reject Ho.			3	3
							3	3
							3	3
				Meaning			3	3
				There is no real difference between students' perceptions on the importance of paper upcycling in reducing pollution and preserving natural resources before and after the intervention.			3	3
							3	3
							3	3
							2	3
							2	2
							2	2
							2	2
							1	2
							1	2
							1	85
							83	

There was a slight increase in the percentage of students who strongly agree and agree that paper upcycling is important for reducing pollution and preserving natural resources after the workshop. However, the statistical analysis revealed no significant difference between the pre-test and post-test, indicating that although there was some change in the responses, it was insufficient to be statistically significant.

Table 5. *Gathered data for question number 5, belief that upcycled paper products can be as valuable as new paper products.*

Response Category	Pre-test (Actual Data)	Pre-test (Percentage)	Post-test (Actual Data)	Post-test (Percentage)
Absolutely Disagree	13	44.8%	0	0%
Disagree	12	41.4%	0	0%
Agree	1	3.4%	9	58.6%
Absolutely Agree	3	10.3%	19	24.1%

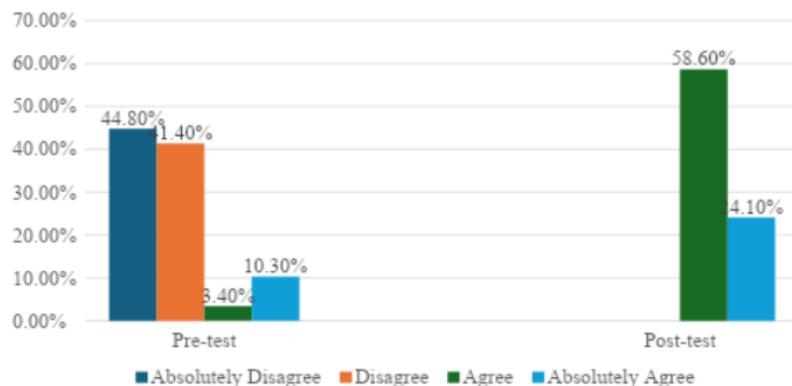


Figure 5. *Proportion of data for belief in upcycled paper products*

In the pre-test, 86.2% of respondents either disagreed or absolutely disagreed with the belief that upcycled paper products could be as valuable as new paper products. In the post-test, this dropped to 0%, showing a complete shift in perception. A significant increase in the "Agree" category (from 3.4% in the pre-test to 58.6% in the post-test) and the "Absolutely Agree" category (from 10.3% in the pre-test to 24.1% in the post-test) suggests that, over the course of the study, students' perceptions of the usefulness of upcycled paper products improved significantly. The data indicate that students became more open to the idea that upcycled products can be just as valuable as new ones.

Table 6. Gathered data for question number 6, belief that upcycling paper waste can help reduce material costs

Response Category	Pre-test (Actual Data)	Pre-test (Percentage)	Post-test (Actual Data)	Post-test (Percentage)
Absolutely Disagree	12	41.1%	0	0%
Disagree	0	0%	4	13.8%
Agree	13	44.8%	17	58.6%
Absolutely Agree	15	51.7%	7	24.1%

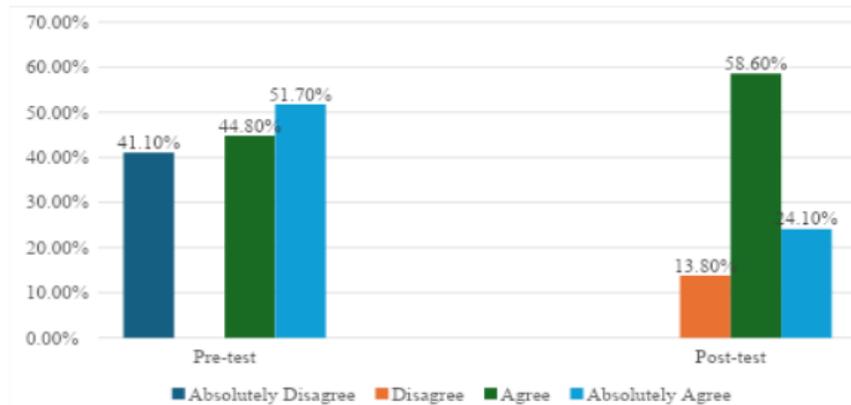


Figure 6. Proportion of data for belief in upcycling to reduce material costs

In the pre-test, a large portion of respondents (41.1%) "Absolutely Disagreed" with the belief that upcycling paper waste could help reduce material costs. However, in the post-test, this percentage dropped to 0%, indicating a complete shift in opinion. Additionally, the percentage of respondents who "Agreed" or "Absolutely Agreed" that upcycling could reduce material costs increased significantly, from 44.8% and 51.7% in the pre-test to 58.6% and 24.1%, respectively, in the post-test. This indicates a positive shift in students' beliefs about the potential economic benefits of upcycling paper waste. The data suggest that, over the course of the study, students became more convinced of the ability of upcycling to help reduce material costs.

Table 7. Gathered data for question number 7, belief that upcycling paper waste could potentially create revenue for the school.

Response Category	Pre-test (Actual Data)	Pre-test (Percentage)	Post-test (Actual Data)	Post-test (Percentage)
Absolutely Disagree	0	0%	0	0%
Disagree	12	41.4%	2	6.9%
Agree	9	31%	20	68.9%
Absolutely Agree	7	24.1%	6	20.7%

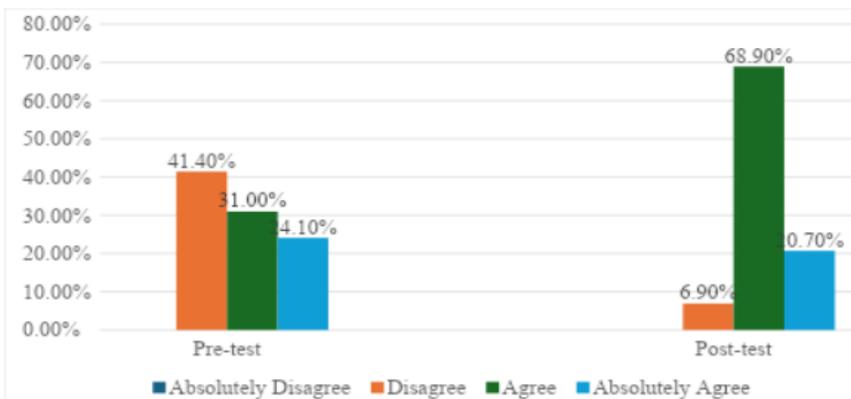


Figure 7. Proportion of data for belief in upcycling to reduce material costs





Table 10. Creativity and Application

<i>Criteria</i>	<i>Yes</i>	<i>No</i>	<i>Comments/Notes</i>
Did the student show creativity in designing their upcycled product?	6	0	100% of students demonstrated creativity in their designs. Observers noted that 6 out of 6 felt the creativity was evident in the final products.
Did the student apply the sustainability principles discussed in the seminar?	6	0	100% applied sustainability principles, using waste paper from their school and home.
Was the student able to contribute innovative ideas for upcycling?	6	0	100% contributed innovative ideas for upcycling.

The students demonstrated creativity and a strong understanding of sustainability principles during the workshop. They not only applied these principles by using waste materials but also generated innovative ideas for new upcycled products.

Table 11. Collaboration and Teamwork

<i>Criteria</i>	<i>Yes</i>	<i>No</i>	<i>Comments/Notes</i>
Did the student work well with others in a team?	6	0	Overall, 100% of the teams worked well and able to produce the desired output, although 4 out of 6 observers noted that "some students did not helping I in the given tasks".
Did the student help others when needed?	6	0	100% helped each other when necessary.
Were the students respectful towards peers during the workshop?	6	0	100% respectful towards peers.

The students demonstrated good teamwork skills and respect for their peers. However, a few students showed less active participation in helping their group, but overall, collaboration was effective.

Table 12. Understanding of Sustainability Principles

<i>Criteria</i>	<i>Yes</i>	<i>No</i>	<i>Comments/Notes</i>
Did the student demonstrate an understanding of the environmental benefits of upcycling?	6	0	100% understood environmental benefits.
Did the student understand the economic benefits of upcycling, such as cost savings or potential revenue?	6	0	100% understood the economic benefits, including cost savings.
Did the student incorporate sustainability concepts into their product design?	6	0	100% incorporated sustainability concepts into their designs, using only upcycled materials.

Students showed a clear understanding of both the environmental and economic benefits of upcycling. They applied these concepts directly to their designs and demonstrated an awareness of sustainability during the workshop.

Table 13. Behavior During Workshop

<i>Criteria</i>	<i>Yes</i>	<i>No</i>	<i>Comments/Notes</i>
Was the student focused on their task during the entire workshop session?	6	0	100% stayed focused throughout the session and completed their tasks before the deadline.
Did the student display positive attitudes toward the project?	6	0	100% displayed positive attitudes throughout the session
Did the student remain engaged throughout the entire project duration?	6	0	100% remained engaged and completed their projects in a timely manner.

Students displayed excellent behavior during the workshop. They were focused, positive, and engaged, ensuring they completed their tasks before the deadline.

## Conclusions

This study demonstrates that an upcycling workshop can effectively raise students' awareness of sustainability issues, particularly in terms of reducing paper waste and understanding the economic and environmental benefits of upcycling. The results show a significant shift in students' perceptions of the value of upcycled products and a marked increase in their awareness of sustainability. The study highlights the potential for schools to incorporate sustainability education into their curricula and explore practical initiatives like upcycling projects to reduce waste and generate revenue. By providing students with hands-on experiences, educators can help foster a generation of environmentally conscious individuals who are empowered to make a positive impact on the world.

Future research could address several areas to build on the findings of this study. One recommendation is to use a larger sample size to increase the generalizability of the results. Additionally, exploring the long-term effects of sustainability education, particularly in the context of upcycling, would provide valuable insights into how students' behaviors and attitudes evolve. Research could also include different age groups to understand how sustainability education impacts students of various developmental stages. Another area for future research could be a comparison with other teaching methods, such as multimedia-based instruction, to determine which methods

are most effective in promoting sustainability awareness. Lastly, expanding the research to include broader sustainability practices, such as energy conservation and waste reduction, would help create a more comprehensive approach to sustainability education.

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