Promoting Innovative Sustainability in the Classroom: Integrating Ecological Considerations into the Process of Food Delivery Packaging Design

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Abstract: The Covid-19 pandemic has led to an increase in plastic waste, especially in food delivery packaging, prompting the need to educate future designers on sustainable packaging. Researchers conducted a post-pandemic study with 48 students in packaging design classes at two universities. The students were tasked with designing packaging for various food products, demonstrating the creative process involved in food delivery packaging. The students followed an action research process model, presented a preliminary prototype, and underwent pre- and post-test experiments to explore the impact of the ecological consideration curriculum on their soft skills and experiential learning. During the implementation process, students faced many educational challenges, including material limitations, balancing environmental responsibility with functionality, and improving designs based on feedback. Throughout the different phases, the students learned to adapt, think innovatively, collaborate, and improve their designs for sustainable packaging solutions. Experimental results showed that the curriculum program stimulated academic learning, developed problem-solving skills, and engaged students in real-life experiences. This research provides a case study for continuously improving packaging design courses, considering Sustainable Development Goals and emerging issues in packaging practice.

Keywords: Action Research, Nature, Packaging Design, Recycling, Waste

1. Introduction

The increase in plastic waste due to packaging has become a significant problem reported in the Malaysia news on 4 August 2021 (Ravindran, 2021). The popularity of online food delivery platforms has led to the increased use of plastic containers and bags during the delivery, while packaging for delivery is essential for the convenience, safety, and ease of delivering food to the customers' homes. However, a growing number of millennial consumers who are regularly ordering food online shows a

clear concern for the environment, and using packaging made from eco-friendly materials can help to increase the brand's perceived value when shopping by consumers (Leung, et.al.,2023) and increase restaurant net revenue. However, the ability to apply environmental considerations in the sustainability of product packaging is limited (Nguyen et al, 2020).To address this packaging issue, we know that presently the European Union including Japan and South Korea have established comprehensive Extended Producer Responsibility (EPR) policies and plans for various products, ranging from the producer of packaging to the recycling and disposal of waste, and while this EPR's implementation has begun, in some regions of emerging countries it has not fully taken effect, and while awaiting the improvement of EPR implementation in these countries, such as Malaysia, the responsibility falls on packaging designers to begin caring about the choice of packaging materials to reduce reliance on raw materials and thus minimize the disposal waste. Environmental Protection Encouragement Agency (EPEA, 2010). In addition to considering aesthetics and usability, the design process must also consider all raw materials. They start from a nutrition perspective and consider how packaging can be recycled (Bou-Mitri, et. al 2020). Langley, et al. (2021) believes that products that combine product packaging and environmental protection can be sold in an environmentally friendly manner. The learning and educating of sustainable packaging design shall begin from college in the packaging design course.

The objective of this study is to lead future designers to learn about eco-friendly design, sourcing environmentally friendly materials, and reducing excessive layers in packaging through the teaching process of a packaging design course, allowing design students to proactively engage and solve real-world challenges, such as the constraints on material choices, the availability and or higher cost of sustainable materials, and finally, leading students to recognize the value of local traditional materials and understand how to incorporate these cultural elements that are both environmentally friendly and culturally distinctive.

Therefore, this study took the packaging design course as an experimental teaching practice and invited students to design green packaging for commercially available foods and provide a better practical experience. This study aims to provide a reference for the teaching practice of green awareness courses and environmentally friendly materials in packaging education.

2. Green Design Packaging

The World Commission on Environment and Development (WCED) has committed to [Our Common Future] in the following statement in 1987: *Sustainable development is the type of development that meets the needs of the present without compromising the capabilities of future generations.* The Earth Summit in Rio in 1992, strives to conclude international agreements that respect the interests of all and protect the integrity of the global environment as well as the development of systems, recognizing their integrity and interdependence. And environmentally friendly design is one of the key factors that bring economic benefits, marketing strategies, eco-friendly materials and reducing unnecessary layers in packaging, as some countries have began to limit excessive product packaging (Schifferstein, et. al, 2022).

2.1 Green Life Cycle Design

Yang (2011) once pointed out that the internal life cycle consists of four parts: the production phase, the transportation phase, the use phase, and the remanufacturing phase. Furthermore, he stated that in environmentally friendly packaging, paper packaging materials are currently the main type, supplemented by plastic, followed by metal, glass and other types of materials. he mentioned that when developing environmentally friendly packaging, pay attention to the selection of packaging materials, reduce the use of packaging materials and printing inks, while proposing to achieve minimalist efficiency. In addition, the effect of structural design can be effectively used to increase durability instead of increasing the amount of packaging material.

2.2 Extended Producer Responsibility (EPR)

EPR is an environment designed to ensure that the manufacturer of a product is responsible throughout the product's lifecycle, especially during recovery, recycling, and final disposal of the product (including its packaging). EPR systems place legal responsibility on product and packaging manufacturers, product manufacturers, brand owners, and original importers for the collection, recycling, and end-of-life management of materials (Kosior & Crescenzi, 2020).

It is based on the "polluter pays" principle and requires waste producers to take responsibility for waste collection and disposal, thus holding the industry accountable for waste recycling and disposal. By recycling used products, the industry incentivizes the design of products that improve reusability. This encourages the development of designs (Siek Hwee Ling & Lee Cheng Ean, 2021) that increase recyclability and minimize the impact of products that can remain in waste streams and contribute to ocean pollution. In developing and emerging countries, implementation of EPR plans has begun in some regions, especially in Latin America and Asia, but most plans were partially implemented and not fully operational.

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2.3 Sustainable Development

The United Nations announced the Sustainable Development Goals (SDGs) for 2030, SDGs goal 12, "Ensure sustainable consumption and production patterns"of which referred to promoting a green economy and ensuring responsible consumption and production. This is an important strategy adopted by the Malaysian local government and integrated into national development plans as part of enhancing environmental sustainability through green growth (Prime Minister's Department, 2022).

2.3.1 Sustainable Development Goals

The SDGs goal 12 is to improve existing products and services and enable the future will be more environmentally friendly. Effective collaboration with the 3Rs of environmental protection (reduce, recycle, reuse). Packaging materials are important to consumers, materials are chosen that are recyclable, biodegradable, and biodegradable over time to benefit the environment (Nguyen,et al, 2020; Kong, et.al. 2023). Design educators can share and educate the students on how to reduce negative environmental impacts by using as little packaging material as possible and avoid wasting resources.

2.4 Packaging Design Course

The purpose of packaging design is to protect the product and to increase the added value of the product (Gay,2018). Packaging design course is one of the core courses in the second year of the university's Bachelor of Graphic Design programme, it carries 4 credits (1 hour of lecture per week, 3 hours of tutoring, and each week students need to report their progress), this experiment teaching practice is scheduled with a duration of 7 weeks.

This course introduces three categories of packaging: flexible, semi-rigid, and rigid. Flexible packaging is packaging or containers made of flexible or pliable materials that can easily change shape during filling or closing, reducing storage space. This structure can be made of paper, foil or any combination thereof. These can be bags, shopping bags, envelopes, or bags that change shape when filled with contents.

The packaging design class is to introduce and teach about the connection of form, structure, materials, and regulatory information to make sure that the packaging can well contain the product, and color, imagery, and typography to make a product suitable for marketing (Siek, et al, 2023) . Meanwhile, the materials used, and the weight of the packaging also must take into consideration, as it will affect the logistic cost and space to host at the warehouse and shelves in retail stores. Robertson (2013) attributed four key functions of packaging containment, protection, convenience, and communication. And to achieve the learning outcomes of the knowledge and skills necessary for this subject, students are required to hands-on experiment to transform their concepts and ideas into the form of visual communication on various materials, mainly using paper or cardboard to do the mock-up including with

correct measurement, the thickness of the materials. And students must ensure that all work is original; they are not allowed to use existing works or copies from the internet to avoid any copyright infringement.

Various packaging such as plastic boxes, cling film, shrink wrap, retort bags, thermoformed products, tin cans, laminated paper sheets, woven bags, jute bags, composite cartons, glass containers, wood, paper bags, moisture-proof paper, etc can be used. Students will be introduced to different thicknesses and grades of paper from 45 gsm to 400 gsm, including various densities from corrugated to cardboard.

For plastic packaging, we also introduce a series of numbers developed by the American Plastics Industry Association since 1988 to identify the quality of plastic packaging using plastic identification codes, we also discussed with students the possibility of applying the CO2 label by consuming local material, such as paulownia or rubber wood, when wooden packaging is required (Taufique, et.al., 2022). Research on all environmentally friendly materials that will replace tinplate and aluminium packaging, tin cans (tinned steel sheets), aluminum tubes (metal tubes) and aluminium foil in the future (Deshwal & Panjagari, 2020).

Compare to the traditional packaging design course, the goal of this course is to equip the students with (Table 1):

Table 1

Green Design course goals

	Course Learning Outcomes	
	Traditional packaging design lessons	Additional topics given to Experimental group
Knowledge	Three categories of packaging. form, structure, materials, and regulatory information. Differentiate the products from the competitors, cost-effective. The materials used, and the weight of the packaging	EPR Applying the CO2 label Consuming local material SDGs Goal 12
Skills	Hands-on experiment to transform their concepts and ideas into the form of visual communication on various materials	Inject the concept of environmental protection into the product Self-awareness ability about green
Quality	all work is original	-

3. Research Methodology

3.1 Design Task

Students were asked to design a group package for a group of three, including both flexible and semi-rigid food delivery packaging. As well as promoting the lunch set campaign with the items below, they can choose one of their favourite cafés or restaurants in town. In addition to promoting and expressing the characteristics of the products and restaurants, the packaging must also be able to protect the product (foods, drinks) and create convenience for customers when taking it away (Peng, et. al, 2023). Here are three elements:

a) Main dishes (semi-moist), such as pasta, rice, etc.,
b) Desserts (dry) such as donuts, cakes, cookies, etc.,
c) Drinks (liquid). can be a hot or cold drink.

3.2 Action Research Model

Action research is a process of construction and deconstruction by Lewin in 1952 and further refined by Kolb in 1984. It uncovers the dialectical relationship between research and practice (Ling, 2020), and teacher-driven cognition in classroom research. The four main components of action research are planning, observation, action, and reflection. It is used to identify intervention areas, collect data, conduct research, analyze and validate results, and evaluate actions. McNiff in 2013 see action research as a type of hands-on research that allows the researcher to engage in their own practical unit of work and complete their research, he defines action research as an inquiry about teachers – an inquiry that aims to explain and advance teaching practice. Studies have explored how action research can train and develop professional competencies and promote educational innovation to bridge the gap between theory and practice (Chevalier, 2019). Action research is considered an effective method to improve professional qualifications, while maintaining autonomy and innovating practical teaching methods.

3.2.1 Action Research Process -Planning

a) Project Brief

Packages fall into three categories: flexible, semi-rigid, or rigid. Flexible packaging. The construction may be of paper, plastic film, foil, or any combination of these. It can be a grocery bag, or pouch that when filled changes shape. The conceptual stage is the time for problem-solving and brainstorming with creative ideas. Students must experiment by turning a conceptual sketch of the packaging into a prototype and during assessment week the prototype will be displayed in class and the learning outcomes will be reported. In this exercise, students will explore food delivery packaging, where it is extremely vital for customers to have the best and most convenient packaging.

b) Purposive Sampling

The research period took place over two semesters – from September 2022 to April 2023 at two different higher education institutions (HEI) in the capital city of Malaysia, with a total of 48 local students (including Malays, Chinese, Indians and indigenous people). The researcher conducted the first semester (Sept to Nov 2022) with 25 participants at A (traditional group), a norm class with no restriction on the material used to design the packaging. In second semester (January to April 2023) with 23 participants at B (Experimental group), (table 2).

Table 2

Participants in the study

HLEs	Year/ Semester	No. of students	BA degree in	The course in which this study was conducted	Duration/ Weeks	Group as
A	Sept to Nov 2022	25	Design Com	Packaging Design	7	Traditional
B	Jan to April 2023	23	Graphic Design	Packaging & Display Design	7	Experimental

c) Researcher's role

This action research process was reported based on experimental group (B). At the beginning of the course, students performed baseline measurements to estimate their prior knowledge about integrating sustainability into environmentally friendly packaging design.

This baseline measurement is an assignment in which students are challenged to design a sustainable packaging concept for a 3-in-1 food delivery packaging. Before that, students are encouraged to come out with creative designs that improve sustainability compared to existing packaging concepts. The students were asked to conduct a field study of the existing packaging of their chosen restaurant and based on the information collected stimulate creative ideas.

d) The Role of participants (students)

Students must research on the assigned topic. A field study was planned and they were able to conduct interviews with the restaurant owner to better understand packaging needs and expectations (Table 2).

3.2.2 Action Research Process -Observation

Conducted research on the current situation of food delivery packaging of the selected restaurants or food service providers, conducted field study to analyse initial problems. The data of the current food packaging are collected within Kuala Lumpur, where there are fast food restaurant chains, cooked food centers, hawker stalls, upscale restaurants, cafeterias and convenience store chains. There are a total of four items which the students were required to collect: main dish container, dessert container, beverage container, and packaging carry bag for carrying all these items in a go.

After students carried out the field study and observation, the data shown 100% of cooked food centers and hawker stalls are using Polyethylene (PE) 500ml food grade microwavable plastic clear containers for main dishes such as noodles and rice; 16 oz microwavable transparent plastic cup with lid or High-Density Polyethylene (HDPE) 500ml plastic bag for cold drink or with ice cubes or hot beverage. All these items are packed in a plastic singlet bag. Additionally. restaurants, café and convenience stores use a similar type of packaging as the food stalls above (58%), with some restaurants using microwaveable food-grade black plastic (Polypropylene) (Siew et al.,2024), PP container (32%) or paper bowls with transparent lids for main courses and desserts (10%), cold drinks are mainly packed in plastic cups with sealed plastic lid to prevent leaks and spills. whereas these paper coffee cups are coated with a thin layer of plastic, which may leak toxic chemicals into the environment. And 80% of all these restaurants use clear PP clear plastic singlet bags as carry bags, 10% use biodegradable singlet bags, and 3% use potato starch singlet bags which are made from 100% compostable material or 3% kraft paper bags as carry bags. All these containers are unbranded or have no manufacturer's identity. Some upscale restaurants, cafes and convenience stores print their logos on their packaging. The samples of main courses, desserts, drinks and carry bags mentioned in this article were randomly selected from students' presentations (Table 3).

Table 3

Samples of take-away packaging form the market places in Kuala Lumpur, Malaysia

	Main dish	Dessert	Beverage	Carry bag
Cooked food Centers & Hawker stalls				
Upscale restaurants, café and Convivence stores				 

3.3.3 Action Research Process -Action

After gathering relevant resources, students begin to compare and determine which materials are sustainable and affordable for food delivery packaging, the following design process was performed:

a) Design Analysis

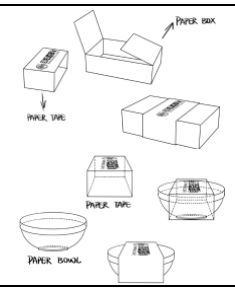
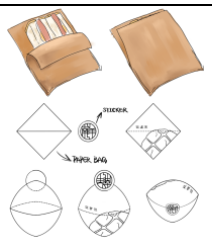
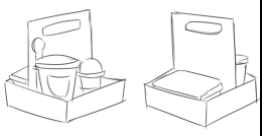
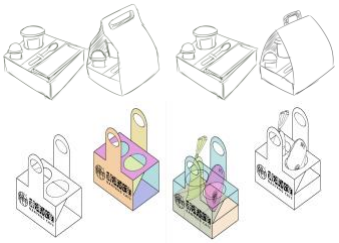
Through market research, internet and library reference materials, the students determined what are the good packaging types used in the international market such as cold drink cups, made from materials such as corn with sustainably sourced PLA or paper, where they are certified by the North American Biodegradable Products Institute (BPI®), this material can be decomposed by microbial activity and heat in the manufacturing facility produces compost in 180 days, but this material is only available in some countries. However, in Malaysia there are manufacturers producing 100% bio-compostable plant-based materials with no chemicals or catalysts for packaging and paper-based food packaging (Foodabox n.d.) which can reduce single-used plastics and lessen our own carbon footprint and start to promote environmental awareness.

b) Design Execution

During this phase, the students were depressed and upset when they realized that they could not eliminate the use of plastic in packaging, especially cups but they could at least minimize plastic and carbon emissions through local manufacturing. They found that despite the limited materials and costs available to Malaysian manufacturers, they were intrigued by the environmental benefits and could focus on designing and developing high-quality packaging design styles within the budget of companies with limited resources. They began brainstorming by exploring wild and unconventional ideas for eco-friendly materials for 3-in-1 group testing (Table 4).

Table 4

Sketches by students

Main dish	Dessert	Beverage	Carry bag
			

3.3.4 Action Research Process -Reflections

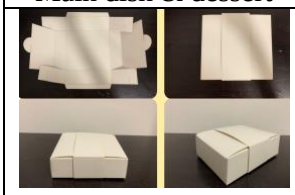
After evaluating the content, collecting data and implementing improvements through testing for further improvement, students designed and created mock-ups of the main course, dessert and carry bag. students commented that while designing and creating the model, they realised that for hot drinks only double-walled disposable ready-made cups (with inner PE coating) were available, and PET cups are the mainstream packaging for cold drinks.

Feedback from manufacturers indicates that these materials are considered sufficient for practical use in the local market, they are not required by law to create more environmentally friendly beverage containers. Looking at the second column of table 4, No new cups were designed, It shows that when it comes to cups, whether for hot or cold drinks, students were unable to redesign new materials for beverage containers and instead stopped at the cup holder. It has been determined that the issue regarding beverage containers cannot be resolved at this time.

Students are more interested in designing the carry bag that allows them to better express their ideas. They experimented with packaging using art paper, white poplar (140 gsm to 210 gsm), art card (300 to 400 gsm), and kraft paper (210 gsm to 300 gsm). This step includes careful review, measurement, and interpretation of results, allowing for a continuous cycle of stakeholder consultation and improvement (Table 5).

Table 5

Trial tests & mockups

Main dish & dessert	Cup	Carry bag
		

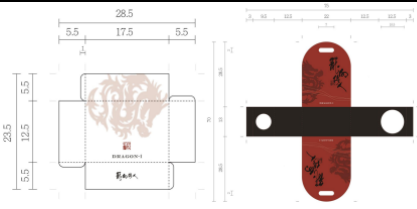
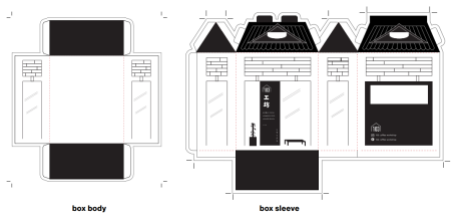
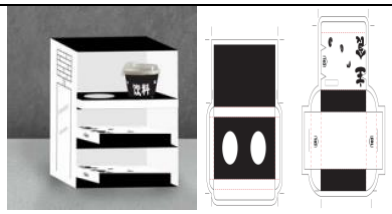
The multifaceted nature of this goal is highlighted by the current disparity observed in the composition of the food containers designed by 48 students, as not all containers can combine 100% environmentally friendly materials. The complexity of sustainable packaging design becomes especially apparent when considering different types of packaging.

While addressing challenges related to carry bags involves a relatively straightforward process of designing and laying out flat plan artwork, integrating corporate colours, and identity markers, the scenario is markedly different for liquid containers, such as those used for beverages. The physical properties of liquids introduce distinct limitations on material options. The decision-making process for these containers is intricately tied to the material availability and compatibility with food packaging manufacturing processes. This complexity forms a practical challenge that students must grapple with, especially when aiming for packaging solutions that are both pragmatic and cost-effective.

After undergoing several iterative trials, the students evaluated and selected the most feasible model to implement in the 3-in-1 packaging design. This involved navigating the complex interaction of design elements, material constraints and manufacturing feasibility. This research therefore constitutes a valuable resource, providing a scientific lens through which future designers can navigate the complexities of information architecture and sustainable packaging design (Table 6).

Table 6

Final outcomes of the design of food delivery packaging

Open plan/ ready for mass production	Flexi-structure packaging	Visual presentation
		
		

After several mock experiments, the students realized that the traditional wraps in Malaysia, such as the typical *Nasi Lemak* (rice cooked in coconut milk that locals love), seemed to be the best. It is wrapped in a banana leaf in the shape of a pyramid, whereas *Ketupat* (rice is stuffed into a pouch and cooked, the cooked rice expands and is compressed into the shape of the pouch) is woven into a pouch made of coconut or Palas leaves, or similar to Chinese rice dishes, wrapped in lotus leaves or in bamboo leaves (the Chinese rice dumpling) and even dessert such as *Pulut panggang* (glutinous rice filled with dried shrimp blended with hot spices) *and Otak Otak* (ground fish mixed with spices wrapped in leaf parcels), all of these leaves do not contain toxins, pigments, and irritants. What they have in common is the flexibility to fold without breaking and of course, high water resistance. In some cases, the leaves are pre-soaked by steaming, boiling, or grilling and these leaves are said to emit fragrance when cooked (Table 7). Otherwise, the decision will depend on what the food packaging factories can supply (Hu, 2021).

Table 7

Traditional leaves packaging in Malaysia

Main dish				Dessert	
Nasi Lemak	Ketupat	Rice in lotus leave	Chinese dumpling	Pulut panggang	Otak Otak
					

4. Evaluation of the implementation of the Green Packaging Design Curriculum

In this study, we conducted a pre-and post-test experiment to investigate the impact of implementing an environmentally friendly packaging course on students' soft skills and learning experience. The two groups were the traditional group (25 students) and the experimental group (23 students). Although the two groups of students were taught by the same lecturer in two different semesters, the teaching process and mode of conduct were not correlated with the variables. The traditional group used open resources such as plastic and pulp paper in their packaging design, while the experimental group were allowed to use only environmentally friendly materials. The experiment was overseen by two researchers. After the seventh week of classes, all students were asked to complete an evaluation form to assess their soft skills and learning experience.

4.1 Data Collection and Processing

This study used the survey method for data collection. Feedback questions were collected from the two universities where this experiment was conducted. Questions were collected using their standard student evaluation questionnaire distributed to students by the university before the end of the semester. Similar questions were then combined, after discussion with two education experts. such as: "*The learning activities contributed to my research* and *the learning resources supported the learning of this subject*". Student participation in this survey was completely voluntary.

The impact of the course on students' soft skills and learning experience was assessed. Soft skills include academic stimulation, communication skills and presentation, teamwork, and Developed problem-solving skills and time management. The Learning Experience Scale analyzes the development of industry knowledge, practical experience, technical skill development, Critical feedback, and Learning Outcomes Achieved (table 8). A total of 47 valid questionnaires were collected (24 in the traditional group and 23 in the experimental group), with a validity rate of 98%.

Table 8

Student Feedback basic information

	Questions		Questions
Soft skills	Academic stimulation	Learning Experience	Industry knowledge
	Communication skills and presentation		Practical experience
	Teamwork		Technical skill development
	Developed problem solving skills		Critical feedback
	Time management		Learning outcome achieved

4.2 Teaching Effectiveness Analysis

4.2.1 Soft skills

The results of the independent sample T-test on the soft skills capability, there are no significant differences in communication skills and presentation ability ($t=1.21$, $p=0.23>0.05$), teamwork ($t = 1.34$, $p=0.19 > 0.05$) and time management ($t = 0.76$, $p=0.45 > 0.05$) but there are significant difference in academic stimulation ($t=2.85$, $p=0.005 <0.05$), and developed problem-solving skills ($t=2.78$, $p=0.007<0.05$) (table 9).

Table 9

Pre- and post-tests of soft skills

Soft skills	Average value (standard deviation)		T-test value	*P* value
	Traditional Group (n-24)	Experimental group (n=23)		
Academic stimulation	3.89 (0.84)	5.46 (0.52)	**2.85***	0.00
Communication skills and presentation	4.13 (0.91)	3.93 (0.68)	1.21	0.23
Teamwork	3.97 (0.64)	3.74 (0.73)	1.34	0.19
Developed problem-solving skills	3.64 (0.71)	3.26 (0.62)	**2.78***	0.00
Time management	6.58 (1.52)	6.38 (1.08)	0.76	0.45

*are significant at $p < 0.05$

4.2.2 Learning Experience

The results of the independent sample T-test on the learning experience showed that after attended the course, there are no significant difference in Industry knowledge, （t=0.76， p=0.45 > 0.05 ）Technical skill development （t = 1.81， p=0.57 > 0.05） and Learning outcome achieved （t = 1.21 ， p=0.23 > 0.05），students in both groups learned and understand functional, aesthetically pleasing packaging solutions that meet consumer needs and market requirements, further develop their technical skills, and achieved the learning outcomes for this course.There are significant difference in Practical experience (t=4.33, p=0.005 <0.05) and Critical feedback (t = 2.46， p=0.016 < 0.05) (table 10).

Table 10

Pre- and post-tests of learning experience

Learning experience	Average value (standard deviation)		T-test value	*P* value
	Traditional Group (n-24)	Experimental group (n=23)		
Industry knowledge	6.58 (1.52)	6.38 (1.08)	0.76	0.45
Practical experience	10.33(1.37)	6.83 (2.73)	**4.43***	0.00
Technical skill development	9.9 (1.28)	38.76(2.77)	1.81	0.57
Critical feedback	3.92 (0.88)	3.52 (0.72)	**2.46***	0.01
Learning outcome achieved	4.13 (0.91)	3.93(0.68)	1.21	0.23

*are significant at p < 0.05

4.3 Integrating Ecological Considerations in Curriculum

Action research significantly expands the learning of environmentally friendly packaging design by providing an iterative and hands-on approach. Engaging in this dynamic process, the experimental group of students actively participates in solving real-world problems related to sustainable design. Through this experiential learning, students understand not only theoretical concepts but also acquire practical insights into the challenges and opportunities in this field. As a result, integrating action research into classroom practice enhances the overall learning experience and equips a generation with the skills, knowledge and adaptability needed to tackle the complexities of green packaging design.

5. Suggestions

According to the analysis of teaching effects, green packaging design courses can significantly improve teaching effects, promote course implementation to avoid the normalization of courses, and ensure that designs are inclusive, recyclable, and consistent with sustainable development goals. Students in the experimental group performed better than students in the traditional group, indicating that the green curriculum can stimulate their desire to apply recyclable materials, reduce waste, and create environmentally friendly packaging solutions and their participation in real-world projects highlights the importance of sustainability practices in packaging design. Understand the ethical implications of packaging design. The students in the experimental group began to learn by observing and solving the current packaging problems in the marketplace, which allowed them to reconsider the packaging that they have ignored in their daily lives - natural packaging materials, namely traditional leaves. These natural materials have properties that facilitate optimal air circulation, thereby addressing an important aspect of packaging that is often overlooked and these materials provide a biodegradable solution. This highlights the importance of adopting packaging inspired by nature, but also adopting methods that improve the sustainability of these materials.

Students learn how to adapt to a changing environment, particularly in response to uncertainty and resource constraints. They learn how to design creatively with limited resources and find low-cost

but effective alternatives to the high cost of sustainable materials. For example, they may consider using discarded materials for redesign or discover local ways to use sustainable materials, these are experiences that help them better cope with resource constraints and budget constraints in future workplaces. Students also learn to quickly adjust designs based on market feedback, which means they can adapt more flexibly to changes in consumer demands and adjust design directions according to the latest market trends to ensure that the products are competitive in the market.

These skills and experiences empower the students to better face challenges in real work environments after graduation. They can adapt more quickly to the fast pace and high variability of the design industry, and can bring greater value to businesses and society through innovative thinking.

The students are involved in real-world experiences and their learning by learning about eco-friendly packaging, students can deepen their understanding of materials towards environmentally friendly packaging. This research provides a case study for the continuous improvement of packaging design courses and the insights gained from the research will help make courses smoother, taking into account the Sustainable Development Goals and changing issues in packaging practice. This study can also form a butterfly effect that helps achieve a bottom-up approach that extends Producer Responsibility (EPR) for packaging to increase recyclability.

6. Co-Author Contribution

The authors affirmed that there is no conflict of interest in this article. Hwee Ling Siek carried out the action research and interpretation of the results, Ya-Kuan Chou prepared the literature review. Chi-Hung Lo wrote the research methodology and the statistical analysis, and Sirada Vaiyavatjamai did the data entry and overlooked the write-up of the whole article.

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