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# Sustainable Fashion Design Module Development for Higher Education : Adaptation of ADDIE Instructional Model

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Sustainable Development Goals,  
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## Abstract

Due to the fashion industry taking responsibility for their garment manufacturing, a significant number of UK universities are focusing on combining sustainability in their curriculum to support future employees' skills and knowledge in sustainable fashion. A proper understanding of educational and instructional theories is needed to develop effective teaching and learning materials and environments. Therefore, this study aimed to evaluate the Fashion Design module created with consideration of sustainability using ADDIE instructional model. For evaluation, the teaching materials, including the module brief and the PowerPoint slides for each session, were used. Ten students were interviewed and observed along with two tutors, also interviewed to analyze the strengths and weaknesses of the module from a variety of viewpoints. With sustainable fashion being embedded into specialized higher education courses, tutors decided to incorporate sustainability into the module as an introduction to this topical subject in order to build a stronger foundation of knowledge and challenge traditional ways of working. Results showed that combining sustainability into the design and technical sessions had a positive influence on students who built upon their existing knowledge. Tutors researched the need for change within the industry in line with the Sustainable Development Goals and aligned the content to inform the students of the current crisis. This study could provide a guideline to create instructional material for sustainable fashion design courses.

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## I. Introduction

A considerable number of UK universities are taking a focused view to combining sustainability in their education to improve the future employees' skills with having sustainable consideration as many fashion brands are taking responsibility for their garment production. The United Nations (2021) founded the Sustainable Development Goal (SDG) initiative, a collective of 17 interlinked global goals designed to create an improved sustainable future for all.

The module in this study was designed to apply Sustainable Development Goal number 12 (SDG) to the garment design and manufacturing process using stretch fabric to encourage students to consider its impact at every step of the project. The combined approach of using sustainability and stretch fabric will help students develop their own solutions for sustainable fashion design. Hethorn & Ulasewicz (2015, p. 393) state that "altering the placement/position of an artefact/object in relation to its surroundings changes how we respond to it, and often this is also linked to changes in its perceived value". Students will design with an identified target audience in mind and will be introduced to elements of modular fashion where designers experiment to create multifunctional garments through the use of fasteners and creative pattern cutting (Hethorn & Ulasewicz, 2015). These solutions help to extend the life and usage of the garments created, preventing fabrics from ending in a landfill. With the use of design thinking, "a human-centred approach which is driven by creative and analytical thinking, customer empathy and iterative learning" will aid the students to practically find solutions to SDG 12 through their work (Curedale, 2016, p. 48).

### 1. Research Background and Motivation

"Although sustainable fashion is not a new phenomenon the actual concept lacks a clear-cut definition" (Henninger, Alevizou, Goworek, & Ryding, 2017, p. 82); however, through education and developing material in

line with the SDGs students' knowledge, actions and opinions on design and consumerism will develop to build an informed view on sustainability within the fashion industry. SDG number 12 was assigned to this module which focused on responsible, sustainable consumption and production patterns while completing the task with consideration of different approaches of post- and pre-consumer waste (Hethorn & Ulasewicz, 2015). Within this module, problems are presented regarding overconsumption and ethical production through tasks, workshops, and lectures where students then work to develop solutions. Within the technical sessions, students will use upcycling to build a final outfit. Fletcher (2014) states that upcycling is a cycle, where the process of transferring waste materials and products onto a new stage of life where there is a new increase value of the original item.

### 2. Purpose and Significance of the Study

The aim of this study is to evaluate a module that applies the educational system model, ADDIE (Analysis, Design, Development, Implementation, Evaluation) to the second year of the BA (Hons) Fashion Design course at Birmingham City University in the UK. The objective is to evaluate the effectiveness of the module through secondary and primary research.

## II. Background

### 1. Fashion Industry's Focus on Sustainable Fashion

Many fashion brands are taking a responsible proactive approach to incorporate sustainability within their garment production due to consumer demand. Rosemary Wallin, an academic and PhD candidate in Technology for Sustainable Luxury at Central Saint Martins mentions in her interview, "it is the most important subject, all of the big brands have Head of Sustainability or sustainability departments, and the designers of tomorrow are going to have to work with those departments and understand the issues at hand" (Central Saint Martins,

2015). According to PR firm Porter Novelli, “94% of Generation Z believes brands have a responsibility to address environmental and social issues” (Simons, 2021).

The household denim brand, Levi’s is a good example of how the fashion industry is considering the environment and sustainability at every step of their production. As Levi’s claim, they are “on a mission to change the clothing industry. For good” (Levi Strauss & Co., 2021). Levi’s is openly discussing how they have not also got it right, however, they are making an effort to improve their product and service. WaterLess, Levi’s latest collection, uses up to 96% less water as denim is known for requiring huge amounts of water to produce one pair of jeans (Morgan, 2020). With the focus on sustainable solutions, Levi’s offer two services giving the consumer a choice between repairing or designing original garments through the tailor shop service available with the mantra ‘Buy better. Wear longer (Levi Strauss & Co., 2021). The denim label focuses on creating a shared bond between the product and the consumer to increase the emotional connection to the garment. Consumer behavior plays a big part in the trend for sustainable fashion and customers’ attitudes can be an important justification as to why people act in certain behavior (Henninger et al., 2017).

Stella McCartney and Prada use regenerated nylon, Econyl®, “eco-friendly and vegan materials to the high fashion market as both cruelty-free and highly transparent” (Jung, Wee & Bae, 2021; Murray, 2021; Park & Kim, 2020). Describing the brand as ‘activists’, McCartney says how she strives to create the most beautiful, desirable products with the least impact on our environment (Stella McCartney, 2021). Alongside the timeline launched in 2001, the brand openly shared their sustainable progress journey with the consumer as they are “on a mission to create luxury fashion that does not compromise on desirability or sustainability. Making every action count” (Stella McCartney, 2021).

As more brands are moving towards developing a sustainable solution to the industry, there has been a rise in smaller independent brands, rental clothing companies and second-hand/vintage consumerism. The consumer

now wants to know the story behind the brand and the product. ‘Tea and Tequila’ is a London / Mexico brand created by two best friends on a mission to protect and promote the craftswomen/men working with them and put them at the heart of the business. Their design pieces help preserve traditional Mexican techniques by giving indigenous communities and individual artisans a new market for their unique craft (Tea & Tequila, 2021). The concept of supporting the environment and giving back to communities that ultimately can be looked over during the production process has grown. Tea and Tequila (2021) also state that their production is slow and small to give less force to individuals involved and the environment as possible, highlighting the notion that slow fashion is worth investing in. As many brands are now partnering and aware of their process, production, and distribution by incorporating biodegradable packaging options. This demonstrates how brands respond to the UN’s SDG pledge with reference to sustainable production and consumption patterns about SDG number12.

## 2. Sustainable Fashion Education

It is essential to reflect the Fashion industry changes into the HE curriculum to produce designers who can share knowledge and ideas to make the industry less environmentally harmful with relevant skills. This is a chance for educators to “turn fashion into a force for good and are focused on having a positive impact on the planet” (Simons, 2021). In order to produce this change, the next generation of designers needs to be able to make informed decisions and responsible actions by reflecting on their learnings because the fashion industry’s mass manufacturing and non-environmentally friendly methods have gone unrestrained (Simons, 2021). Critical targets to achieving sustainability set by the UN are equipping students with relevant sustainability literacies linked to their practical skills and encouraging students to challenge existing systems within the industry. More people consider the purpose rather than just salary when looking for job opportunities (Radclyffe-Thomas, 2021).

Therefore, the need to embed sustainability into the curriculum is critical.

Within the HE curriculum, sustainability has been a global development within Fashion Design at Universities worldwide. Specialist full-time courses have developed into MA programs such as 'Fashion futures' at London College of Fashion, 'Sustainable Design Entrepreneurs' at Fashion Institute of Technology in New York, USA and 'Sustainability in Fashion' at Esmod Berlin, and the International University of Art for Fashion in Berlin, Germany. Focus on combining fashion within the future in an environmentally conscious way through 15–24 months programs. Further opportunities include short specialist courses, which could be a top-up for industry experts or postgraduates BA level. In the Netherlands, Saxion University offers 'Fashion and Textile Technologies' for five months whilst in Italy, Milano Fashion Institute offers 'New Sustainable Fashion' for four weeks compared to London College of Fashion, which offers a short and convenient 'Introduction to Sustainable Design Approaches in Fashion Workshop' covered in 5 days. Showing the demand for these skills are available at every level for those interested. Within these courses, topics such as repurposing / upcycling garments, natural dying, design thinking, hand sewing techniques, and discussing social responsibilities are covered to tackle the whole process within the industry. A combination of skills and techniques is required to cover such a huge industry full of many elements that need to adopt sustainability in their practices.

Specifically, within the UK, the focus in HE is full time at MA level to develop the skills learnt as a postgraduate. As one of the biggest industries worldwide the topic of sustainability needs to be implemented into all elements of the process. This cannot easily be solved within a single module; therefore, specialist courses have evolved where sustainability is the sole focus as Kristen Nuttall, a sustainability consultant comments "Education is the only way we can change this and by engaging our consumer and engaging designers, by engaging industry in general, we can try to make some change" (Central Saint Martins, 2015). Many of the UK courses promote

that after completing their MA students will be left with the necessary skills relevant to make a change in the industry. The University of Brighton promises to leave students as "an effective agent of change – ready to enter a world where sustainable development forms the foundations of good design" (University of Brighton, n.d.).

With the uprising of brands and HE responding to consumer needs, the charity Fashion Revolution evolved after the Rana Plaza building in Bangladesh collapsed in April 2013. Fashion Revolution (2021) mentions how they "believe in a global fashion industry that conserves and restores the environment and values people overgrowth and profit". As one of the world's most significant fashion activism movements, this not-for-profit global movement is active in over 100 countries worldwide. The charity is made up of "designers, producers, makers, workers and consumers. We are academics, writers, business leaders, brands, retailers, trade unions and policymakers. We are the industry and the public. We are world citizens" (Fashion Revolution, 2021). Charity Fashion Revolution demands radical and revolutionary change as they promote their love for fashion but not how it destroys the planet. Built as a community, Fashion Revolution offers education and a platform to voice industry problems. Their manifesto and ten values that align with the UN's SDG initiative hold an annual 'Fashion Revolution Week' with lectures, workshops, and a demonstration. Activities such as #Whomademyclothes grew on social media as students and consumers were challenged to think further about their clothes, designs, and solutions. This helps to promote ownership of actions within consumerism and the industry. The charity focuses on changing the industry from the inside out by doing this.

### 3. Teaching Theories

#### 1) Learning by Doing

Functionalist John Dewey suggested that outcomes from psychological experiments should be developed within education and daily life in 1900 (Schunk, 2020, p. 10).

To build students' awareness of the issues raised and help them understand specifically regarding the SDG, to develop solutions through problem-solving links to real-life industry situations students will face. As Elias (1974) explains, education is to prepare individuals to live within society but also to help them form a better future society through their new knowledge. Dewey reflects on the two outcomes education can have on students: (1) to create a passive risk-free citizen and (2) to create a dedicated and politicized citizen who will fight for the greater good based on concerns for justice, happiness and equality. Within the learnings, students will reflect upon their thoughts, feelings, and actions to grow from this knowledge and work towards building a better society. Dewey's 'learn by doing' theory reflected how educators should prepare students to actively create an improved future by building students' self and social empowerment (Warnick & Stone, 2017). With a student-centered approach, Dewey suggests the art of teaching focuses on understanding the students wants, needs, aspirations, capabilities to connect the students with the subject matter. Dewey understood how the art and design discipline linked with the 'learn by doing' theory, where design ideas are developed. He drew attention to the fact drawing is the initial process where ideas begin and are clarified through pencil and paper. Designing on paper actively defines and forges connections produced as new elements are combined and adapted with existing design ideas and experiences to develop further final designs, evaluated and edited at each stage (Mancha, 2020). As Gaimster explains in her book 'Visual Research Methods in Fashion', all creatives have their approach to engaging and understanding how to create a silhouette and design new shapes. This often includes editing and rejecting ideas after realizing further research is essential; however, sometimes can mean initial ideas are rejected and the process starts again (Gaimster, 2011).

Educators and instructional designers have been using the 'Learning by doing' paradigm in educational programs and systems in various fields. Güzelçoban and Coşgun (2020) mentioned that workshops and seminars

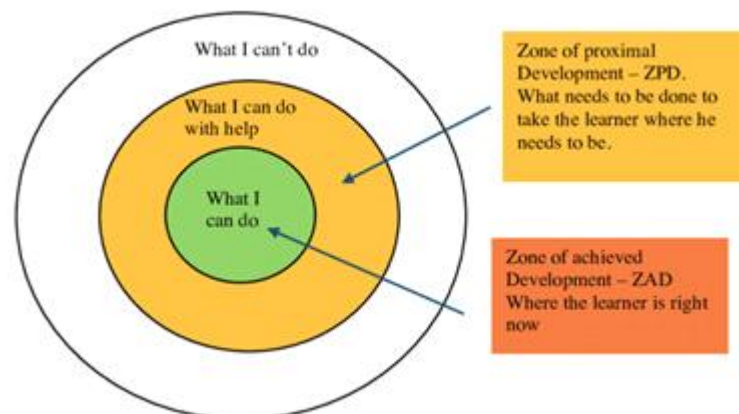
provide opportunities for developing thinking ability to architect students, and Taneri and Dogan (2021) applied the learning-by-doing paradigm in terms of structure and contents to design learning for architecture design undergraduate course. 'Learning by doing' theory is also used for STEM (Science, Technology, Engineering, and Mathematics) education. Chen, Huang, Lin, Chang, Lin, Lin, and Hsiao (2020) used virtual reality technology to create a hands-on experience with the aim of helping students to attain 'learning by doing', and Oehme and Seitzer (2000) analyzed education demand for engineers by finding essential qualifications through learning by doing a project. Abey Siriwardhane, Lützhöft and Ghosh (2021) applied to learning-by-doing approach to maritime design students' educational platform by integrating Human Factors (HF) and Human Centered Design (HCD) knowledge.

## 2) Zone of Proximal Development

Vygotsky invented the concept of the 'zone of proximal development, abbreviated as ZPD, which measured the shift in learners' cognitive growth rather than just the final outcome in 1962 (Kurt, 2020). Students gain knowledge directly from social interactions in class with the support of their instructor, and they should be able to realize their full learning potential. Vygotsky's zone of proximal development is continually characterized by the gap between the present degree of cognitive development and the prospective level of cognitive growth. He believes that students may achieve their learning goals by working with their teacher on problem-solving projects or interacting with more capable peers. Vygotsky also argued that working alone would not allow a learner to achieve the same degree of learning. As a learner leaves his current development zone, "he travels through the zone of proximal development towards his learning goal" (Educational Technology, 2020).

## 3) ADDIE Model

This approach was used as research has proven the benefit of adding structure and support '*instructional scaffolding*' to a practical activity in class or online



**Figure 1. Vygotsky's Zone of Proximal Development and Scaffolding**  
(Educational Technology, 2020)

promoting learning when it helps students focus on achieving targets within an appropriate level of challenge. (Ambrose, Bridges, DiPietro, Lovett & Norman, 2010, p. 132.) Students remain motivated to sustain their efforts if they feel the challenge is doable. This will hold a positive expectation for success, increasing their tendency to continue working hard to achieve that final goal (Ambrose et al., 2010, p. 133). The teaching contents 'opened the students' eyes' to the reality of the industry they will be entering, including the positives, negatives and need for change. By reflecting on their learnings, the students were aware of the issues and have developed an attitude with relevant knowledge to equip them that they are the change. As the next generation of designers, it is up to the students to continue developing solutions to improve the industry's effect on the environment and build a better place to work in.

For many years now, educators, researchers and instructional designers have used the ADDIE instructional model in instructional programs or system development. Many researchers applied the ADDIE model in developing and evaluating instructional curriculum, courses, or training in diverse areas (Alnajdi, 2018; Lee, 2021; Park, 2017; Sahaat, Nasri & Bakar, 2020; Tu, Zhang and Zhang, 2021).

### III. Methodology

Formative research was developed by Reigeluth and Frick (1999) as a research tool for design theories/ models' development and improvement. The aim of the method is for action research to enhance teaching theory for designing instructional practices or applications.

This research uses formative research with a designed case in which the instructional design model is purposefully instantiated and then evaluated (Reigeluth & Frick, 1999). The fundamental logic of formative research is that if a particular application of an instructional design model is developed, any defects found out in the application may reflect defects in the model, and any improvements recognized in the application may echo methods to enhance the model, at least for a subdivision of the situations that the model is aimed (Reigeluth & Frick, 1999).

#### 1. Procedure

A five-phase approach of the ADDIE model is used for conducting the formative research in this study to build effective learning solutions (Table 1).

**Table 1. Detail of ADDIE Model in This Study**

Phase	Detail
Analysis	Learner analysis
	Need analysis
	Topic and task analysis
Design	Learning objectives
	Assessments' design
	Teaching/ Learning strategies
Development	Teaching material development
	Development of teaching materials
Implementation	Training the instructors
	Prepare the learners
	Organizing the learning environment
Evaluation	Formative evaluation
	Summative evaluations

## 2. Sampling

Two instructors and ten subjects are chosen from the population of the target learners in the module using a purposive sampling strategy.

## 3. Method

Observations will be made to confirm model features' presence and see how participants react to them on the surface. In addition, one-on-one evaluations, which include interviews with participants, will be conducted to probe the participants' opinions and identify strengths and weaknesses, investigate improvements for elements, the consequences of removing or adding new elements and different possible situations in the module.

A series of open-ended debriefing questions is used as a guide for one-on-one evaluations with participants. This series of questions progress from broad to detailed, with the goal of gathering information based on the ADDIE model. These questions aim to identify the success of the module and suggestions to improve weaker areas.

## 4. Data Collection

The teaching materials, including the module brief and each session's PowerPoint slides, are collected from design and technical tutors. Interviews with instructors and students are conducted online using Microsoft Teams, and all recordings are transcribed for analysis.

## 5. Analysis Method

The collected data including transcripts of interviews are analyzed both qualitatively and quantitatively. The data is organized into a Microsoft Excel file per questions and participant and then analyzed by open coding methods to identify themes. While reading the data again, researchers highlighted text relevant to the themes according to the researchers' coding criteria then the highlighted text was analyzed into the appropriate nodes.

## IV. Results and Discussions

The ADDIE model, a five-phase approach has been used for analysis to build effective learning solutions.

## 1. Analysis

The first phase of the ADDIE model is Analysis to identify the probable causes for the performance gap (Branch, 2009). In this research, 1) Learner analysis, 2) Needs analysis, 3) Topic and task analysis were conducted for the Analysis phase (Aldoobi, 2015; Kim & Choi, 2006; Lee, 2021).

### 1) Learner Analysis

Firstly, learners' general characteristics and demographic background are analyzed: A learner's age, culture, ethic, diversity, social, and economic characteristics. There were 63 second-year students who partook in the module, of which 57 students submitted their final submissions. Among the 63 students, 48 are Fashion Design pathway, 11 are Costume Practice pathway, 11 are Garment Technology pathway students. This research will focus primarily on the 48 Fashion Design students. The age of students is between 19 to 22 with no mature students, and 46 are female except for two males within the same group.

Regarding ethnicity, the majority are British, but many students are multi-ethnic with a mixture of students from Asian, African, Caribbean, European origins. There are five international students, including three Chinese, one Portuguese, and one Romanian. Next, learners' background knowledge, especially pre-education, knowledge, ability, exceptionality, and attitude, are defined before the start of learning. All students eligible to study on the course have a minimum of 112 Universities, and Colleges Admissions Service (UCAS) points including Grade 4 or above of the General Certificate of Secondary Education (GCSE) in English Language and Mathematics which means they have a basic level of academic knowledge and structure relevant to the course.

### 2) Need Analysis

Students' academic level focused on understanding previous learning intellectual abilities are followed. This need analysis includes determining students' existing

knowledge, skills, technical vocabularies suited to the module. The module designed for this research is in the second semester of the second year. Students on this module have learnt a broad range of essential skills and knowledge on fashion studies in design and construction in their first year before choosing their pathway choice. When students' progress to the second year, 48 students chose the Fashion Design pathway as their specialism to focus their studies. This module provides an opportunity to develop students' advanced creative and technical exploration skills, building on the inquiry skills and ability gained in the first year to advance ideas and professional practice. As for the learning difficulty, some students have dyslexia and attention deficit hyperactivity disorder (ADHD), and persistent attention, and we have one student who has dyspraxia. Students with difficulty in dyspraxia and ADHD can have an extension on their submission, and tutors share their progress and assist with any issues to support them.

### 3) Topic and Task Analysis

The last is topic and task analysis, which focuses on analyzing instructional goals and learning objectives (Aldoobi, 2015; Lee, 2021). This module was designed relevant to trends and the lifestyle of the students in Covid-19 to help develop their knowledge and understanding of fabrications, fit and design features. Focusing on stretch garments in Covid-19 when athleisure garments have become the main wardrobe essentials for 'working from home', in relation to design sessions, the objective is to build an ability to understand the consumer and the target audience because the students could refer to their own clothing, firsthand experiences of buying, wearing and the fit of stretch garments. Students will have opportunities to learn knitted fabric construction and its application into garments by investigating the variety of stretch fabric and manufacturing the garment. The research about sustainable design/ materials/ construction techniques is to be applied to design and development. 'Fashion Detox Challenge (FDC)' is given to develop the students' awareness of the fashion industry's impacts. Students are



challenged not to purchase any garments in the eight weeks.

## 2. Design

The second phase of ADDIE is Design, which verifies the desired performances and appropriate testing method as a learning solution that fits objectives and strategies with instructional goals (Branch, 2009). This phase focuses on organizing clear links between the module content and 1) Learning objectives, 2) Assessment design, 3) Teaching/Learning strategies (Branch, 2009; Lee, 2021; Mohammad & Wan, 2018).

### 1) Learning Objectives

Learning objectives can be determined as achievable and measurable actions to enable learners to fulfil their goals and specific, quantifiable activities to meet instructional objectives (Branch, 2009).

The learning objectives are divided into design and technical elements. As for design, the objectives related to research and design development are set, and technical development and final outfit are addressed as technical part's objectives (Table 2). Each objective occupies 25% of the 40 credits module among 120 credits in total for a year.

### 2) Assessment Design

Based on collected data from the Analysis phrase it should be used for assessment design, and assessment is clearly linked to the content and context. In addition, the tasks need to be written straightforward to minimize

confusion and misunderstanding by the learners (Aldoobi, 2015; Mohammad & Wan, 2018).

This module focused on understanding the property of the diverse stretch fabric and designing and constructing one creative athleisure outfit (a top and a bottom). During the initial design stages, students research the sportswear market alongside a sustainable design approach and have been introduced to stretch garment-making techniques to consider other ways to realize your designs through sewing workshops. Students' designs work utilizes a top and a bottom featuring applied embellishment– this may include upcycling, hand embroidery, beading, and/or fabric manipulation etc. Students are expected to evidence all the processes undertaken from research to design, experimenting, pattern cutting, and the final outcomes within the development folder providing evidence of all the processes undertaken. In addition, students are asked to upload two posts per week by sharing their FDC experiment (Table 3).

Not only assignments but also feedback form with grading rubric is developed to impact student engagement and incorporate educational best practices (Nichols Hess & Greer, 2016). Feedback form is developed with having the area of general comments every three strengths and improvements points on the quality of the submission. Feedforward feedback is also given to apply the feedback to future submissions. The marking rubric is set from 'Fail' to 'First'; 0–39% (Fail), 40–49% (Third), 50–59% (2:2), 60–69% (2:1), 70–79% (First), 80–100% (Double first).

**Table 2. Learning Objectives**

Design	Research	Research and analyze appropriate sources, applying relevant solutions to practical design projects
	Design development	Present knowledge and application of design through relevant research to evidence practical project outcomes.
Technical	Technical development	Through creative and technical exploration, apply knowledge of processes, methods and materials.
	Final finished outfit	Demonstrate and implement critical awareness of final outcomes relating to design and technical solutions.

Table 3. Assessment Requirement

Design		Technical	
Research	Design development	Technical development	Final finished outfit
<ul style="list-style-type: none"> <li>• 10+ Comp shop report</li> <li>• 10+ Research pages (Sketchbook)</li> <li>• 1+ Sport / athleisure mood board</li> <li>• 1+ Target audience board</li> <li>• 1+ Project mood board</li> <li>• Fashion Detox challenge report and Padlet</li> </ul>	<ul style="list-style-type: none"> <li>• 15+ Firsthand drawing/collages</li> <li>• 30+ Initial designs including front, back, side views</li> <li>• 30+ Developed designs with annotation</li> <li>• 6 Final design outfits cohesive including front, back, side views</li> <li>• 2 Tech spec sheets for final outfit</li> <li>• 6 Portfolio- - including intro, mood board, design development, primary research, outfit breakdown, final design</li> </ul>	<ul style="list-style-type: none"> <li>• Documentation of sewing workshops</li> <li>• Samples developed in sewing sessions evidencing stretch techniques</li> <li>• Pattern experimenting in workshop sessions</li> <li>• Toile development and fittings for final outcomes</li> <li>• Documentation of final outcomes' manufacturing processes</li> <li>• Final patterns for final outcomes</li> </ul>	<ul style="list-style-type: none"> <li>• Images of your completed garments including front, back, side, and detail views</li> <li>• Evaluation of the final outcomes and project</li> </ul>

### 3) Teaching/ Learning Strategies

The teaching/ learning strategies should be developed logically to support learners in building knowledge and skills. (Branch, 2009). The delivery methods for teaching are decided to represent the teaching materials by creating instructional strategy and combining diverse methods to assist the learners in the understanding topic (Aldoobi, 2015).

The combination of 'Scaffolded Learning' and 'Learning by doing' teaching theories worked to enhance the student's previous knowledge with relevance to the fashion design industry which they are preparing to enter. Building on the enquiring design, pattern cutting skills and ability gained in the first year, Vygotsky's Scaffolded Learning Approach was used to enhance creative students' development of ideas and professional practice as designers through support structures from tutors with regular feedback sessions.

Fashion design students are additionally taught the 'learn by doing' method where they experiment physically to create and reflect upon the outcomes such as toiles and fit meetings which mirror how the fashion industry

works in order to analyze and develop their own design skills. Vygotsky's Zone of Proximal Development (ZPD) supports, and its structure was used as a framework to assist the students in thinking and actively working through the key stages of design to expand the students' design development. At the beginning of the second year, the students are at the 'what I can do' stage reflecting upon past achievements in traditional design and basic pattern cutting methods learnt. By assisting students into the second stage of the ZPD 'what can I do with help' tutors established new methods of design thinking and technical problem solving to assist students in producing a final upcycled stretch outfit.

A total of eight weeks is given for this module delivery, and each one day of design and technical session has six hours. The formats to deliver in this module are lecture and seminar, technical practice, and self-based workbook. Design sessions are offered online, while technical sessions are taught on campus with the aim of using technical equipment. Considering the students' varied abilities, the formats to deliver in this module include various types of teaching delivery

methods applied; lectures, seminars, technical practices, discussions, peer-reviews, individual/ group tutorials, and self-based workbooks. In addition, a Padlet, an online social platform where students upload their work and ideas, is used to post about the FDC to build an online learning community for the students to share and review each other's ideas and leave comments.

Regarding design sessions, the research about the Fashion industry and SDG, including comparative brand analysis, is given in the first week. The mood board and a new design template were developed in Week 2, and target analysis followed with initial design development at Week 3. From Week 4 to 8, a minimum of 30 designs with having colors, swatches, and details have been developed, and the final chosen design is with technical drawing on a portfolio. FDC report is produced in the whole eight weeks, starting with Closet Mass Index and object-based research.

As for technical sessions, Weeks 1 to 4 focus on

understanding stretch fabrics, especially how to sew using different machines alongside pattern cutting practice for casual garments with stretch fabric. Week 4-8 are more concentrated on textile surface development using upcycling techniques and final garment development.

### 3. Development

The third phase of ADDIE is development, which includes creating learning resources, validating and revising the draft, and performing a pilot test. Firstly, learning resources are developed with a combination of contents and learning objectives by using media as well as generating guidance for teachers and learners. The resources can be approved to perform by reviewing and consequent revisioning, and feedback and observation are collected with offering insight into final amendments (Aldoobi, 2015; Branch, 2009).

Table 4. Example of PowerPoint slide (Images taken by authors)

Gantt chart	Activity
<p><b>WEEK 5: TIME MANAGEMENT</b></p>	<p><b>FABRIC EVALUATION WORKSHEET</b></p> <p><b>TASK</b></p> <ol style="list-style-type: none"> <li>Measure stretch capacity of your fabric             <ul style="list-style-type: none"> <li>Test fabric given for sample making</li> </ul> </li> <li>Fill in Fabric Evaluation Worksheet on Moodle             <ul style="list-style-type: none"> <li>Evaluate your fabric prepared for leggings - both widthwise and lengthwise</li> </ul> </li> <li>Don't forget testing fabric after washing</li> </ol> <p>You can fill in the part for shrinkage after laundering at home as your self-directed study.</p>
Discussion	Homework
<p><b>CREATE YOUR OWN TECHNICAL DRAWINGS</b></p> <ol style="list-style-type: none"> <li>Work on the front view - share in your Breakout room chat. Give written feedback to each other to improve.             <ul style="list-style-type: none"> <li>One thing that has gone well and why.</li> <li>One thing that can be improved and why.</li> </ul> </li> <li>Make changes according to peer feedback. Work on the back and then side view. Follow the same process as before.</li> <li>Start to add colour and texture.</li> </ol> <p>90 mins</p>	<p><b>HOMEWORK FOLLOWING TECHNICAL SESSION 5</b></p> <ul style="list-style-type: none"> <li>Continue developing your <b>technical drawing</b></li> <li>Keep researching other <b>interesting and innovative</b> <b>outdoor design techniques</b> that you can use for this project.</li> <li>Bring your research ideas and all equipment for surface design and garment construction.</li> <li>Read module brief and make yourself understand the requirements</li> </ul>

#### 1) Development of Teaching Materials

The teaching materials are developed using Microsoft PowerPoint. Every session, both online and on-campus, uses PowerPoint slides for teaching material delivery. Each session's presentation slide includes a Gantt chart to remind students of the flow of the overall sessions, prepare the remaining sessions, and catch up on any missing contents. In addition, a schedule of day and aim are provided at the beginning of the session, and slides also include pages of lecture, quiz, discussion, activity, and homework (Table 4).

#### 2) Production of Samples

Providing the appropriate examples and samples are essential for supporting student understanding and progress, and factual sample development should run through the conduction of design (Aldoobi, 2015; Lee, 2021).

Textile surface design techniques are introduced by showing examples – slice, patchwork, weaving, knitting, dyeing, printing, layering, manipulation, embroidery, reconstruction/ deconstruction, and using mixed material. The tutor's explanation inspires students to apply these to their final creative and sustainable garment development. In addition, previous students' examples and other designers' works are also given as inspiration. As shown in Table 5, the samples for technical sessions are developed, and pre-recorded step-by-step guide videos for sample construction are also used as additional supports.

### 4. Implementation

Implementation is the fourth step of the ADDIE model, and it involves putting the plan into action. This phase comprises both instructors and students' preparations and engagements for the learning environment. It includes 1) Training the instructors, 2) Preparing the learners, and 3) Organizing the learning environment (Aldoobi, 2015; Branch, 2009).

#### 1) Training the Instructors



During this stage, it is crucial to sufficiently train the instructor and assures that instructors have all information about teaching before the sessions are started. The teaching materials created during development are given to the instructors to perform their teaching (Branch, 2009; Treser, 2015).

As for this module, two design and two technical tutors are allocated for teaching under 20 of three groups of students. The instructors have confirmed a good understanding of the module aim and objectives and teaching contents by having presentation slides in advance. All tutors are fully knowledgeable about using teaching equipment and software for both online on-campus teaching.

#### 2) Preparing the Learners

The next implementation phase is to prepare the learners, and this starts with finding out students' enrollment followed by pre-course communication and interaction

**Table 5. Stretch Stitch and Garments Sampling (Images taken by authors)**

Week 1 Stitch samples	Week 2 T-shirts	Week 3 Leggings	Week 4 Fly front
			

with the new learning environment (Aldoobi, 2015; Branch, 2009). The module briefing is given prior to the first session to give the information of overview of the module and check if learners have all required materials, tools, and knowledge to the module. The instructors also check if students are familiar with Microsoft Teams to access the online sessions.

### 3) Organizing the Learning Environment

Next is to organize the environment of learners which is coordinating the learner's space to make sure that the technical requirements are prepared. A well-prepared environmental setting allows both learners and instructors to focus on the learning process with the least number of distractions possible (Aldoobi, 2015; Branch, 2009; Lee, 2021; Treser, 2015).

Due to Covid-19, the sessions for the module are delivered both online and face-to-face teaching for design sessions and practical sessions, respectively. Students have their own device to access online sessions, and the Microsoft Teams software to join the sessions have been installed in advance. Regarding practical teaching, a screen projector and adequate size of screen are used to share the slide with students. The suitable condition of furniture has already been prepared at the practical teaching place for pattern cutting and garment construction with enough width and height of tables and chairs. Based on university health and safety guidelines, the tables and chairs for practical teaching places are repositioned to have a determined distance between a maximum of 20 students.

## 5. Evaluation

Evaluation is the final phase of the ADDIE model. Both formative and summative assessments are used, including the instructor's reflections and learning effects as well as students' feedback and interviews (Branch, 2009; Lee, 2021). Before and after implementation, the quality of the instructional design and procedures are evaluated to establish evaluation criteria, choose evaluation instruments, and carry out evaluations (Branch, 2009).

Students' outcomes are collected to categorize them by theme and analyze their design development elements and specific techniques for textile development (Table 6 and 7).

### 1) Final outcomes from students

#### (1) Concept

Two main methods were used to create the final outfit: using a dress form through continual trial and error and traditional pattern cutting. Multiple students experimented with textures on the dress form which developed into their final outcome. Students 8 and 14 both used trouser legs and repurposed them into the arms on the stand as they approached the module with a problem-solving attitude. Students also created pattern pieces and toiling allowed the students to create a guide to achieve a correct fit as per their design.

#### (2) Embellishment

Hand stitching was used by almost all students to create their final pieces or to develop their unique surface design in a bespoke outfit, as Participant 8 mentioned "Upcycling old garments made this garment more unique". Patchwork was also a popular technique to create a new base fabric to begin and create the new garment. This technique was less restricted with creating shape and form on the stand, however, the cut and sew method which links to pattern cutting helped the students focus on developing a specific fit of the garments. Leftover scrap materials were incorporated to achieve zero waste, these scraps were used to add volume to garments (student 4) and to weave with (student 1 and 5) as well as plait within the outfit (student 4 and 9).

#### (3) Color

Throughout the upcycling process, a number of patterns were observed which the students conducted. When sourcing garments many focused on the color and aesthetic of the garments to represent their final outcome, therefore nine students selected garments depending upon how well the base color complimented their chosen design. With regards to color adaptation, the students focused on researching and using

**Table 6. Key Findings from Students' Outcome 1 (Images taken by authors)**

Number	1	2	3	4	5	6	7
Theme	Snow-kiting	Swimming	Golf	Rock climbing	Snow boarding	Football	Tennis
Outcome							
Concept Development	*Combined garments *Focused on the silhouette	*Fluid lines *Created pattern pieces for construction	*Gathering *Layering on stand	*Started with the sleeves first and developed	*Experimented on the stand *Garments linked to the sport	*Cut and sew *Household objects combined	*Created pattern pieces as a guide *Deconstruction
Embellishment	*Hand sewn *Weave scraps *Patchwork *Hand embroidery *Overlocker *Repurposed belt	*Overlock *Laced up corset-like *Patchwork	*Weaving *Applique *Zig zag stitch *Hand sewn	*Scraps for volume *Plating to create rope using scraps	*Patchwork *Boro Stitching *Hand weave scraps *Applique *Frayed *Print	*Sewing machine *Applique	*Patchwork *Machine embroidery *Hand embroidery
Color Adaptation	*Non-toxic dyeing *Tie-dyeing *Acrylic print	*Complementary colour garments selected	*Hand dye	*Natural dyes, e.g. turmeric *Neutral garments chosen *Bright embellishment	*Bleached denim *Dyed denim with food colouring	*Garment selected by colour *Sweet wrappers to match	*Natural dyeing using strawberries and blueberries on lace and mesh
Notes	*Selected textured garments *Embraced errors	*The binding added control to the fit	*Modular for warmth	*Experimented with volume through upcycling	*Modular for warmth *Functionality	*Used household objects for texture *Functionality	*Oversized garments *Used ribbon for fit

environmentally friendly alternatives such as dyeing using fruit and vegetables to create a new color (see students 4, 7 and 12) or combining household elements to add texture and color (see students 5, 6 and 13).




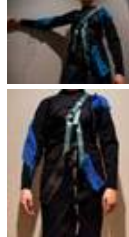



## 2) Formative Evaluations

Formative evaluation is undertaken to verify whether the quality of learning resources meets the requirements established in the Design phase (Branch, 2009). Firstly, module effectiveness with consideration of media

components is evaluated. This evaluation approach focuses on assessing each material that instructors utilized if it was effective and figuring out the strengths and improvement of teaching materials and chosen media (Aldoobi, 2015). Students' performance is also evaluated by determining whether they met the lesson's objective

and observing the behavior in action. Both design and technical tutors agree the module aimed to raise awareness for SDG12 through experiential learning with a subsequent impact on the design side. Through both fashion design and creative pattern cutting skills, a focus was on incorporating stretch, as a high percentage of

**Table 7. Key Findings from Students' Outcome II (Images taken by authors)**

Number	8	9	10	11	12	13	14
Theme	Volleyball	Ballet	Irish Dancing	Deep-sea diving	Roller Skating	Hockey	Mountaineers
Outcome							
Concept Development	<ul style="list-style-type: none"> <li>*Researched environmentally friendly solutions</li> <li>*Used three fabrics to create the final</li> </ul>	<ul style="list-style-type: none"> <li>*Made textures and decided on the placement on the body to create silhouettes</li> </ul>	<ul style="list-style-type: none"> <li>*Focused on ruffles and gathers down the legs</li> <li>*Incorporated plastic for structure</li> </ul>	<ul style="list-style-type: none"> <li>*Cut and sew</li> <li>*Customer considered throughout</li> </ul>	<ul style="list-style-type: none"> <li>*Cut and sew</li> <li>*Deconstruction</li> <li>*Unwound old garment for yarn for pom poms</li> </ul>	<ul style="list-style-type: none"> <li>*Focus on drape and shape of fabric with textiles manipulation</li> </ul>	<ul style="list-style-type: none"> <li>*Cut and sew</li> <li>*Focus on creating shape</li> <li>*Designed from collage and the stand</li> </ul>
Embellishment	<ul style="list-style-type: none"> <li>*Invisible hand stitching</li> <li>*Cross stitch embroidery</li> <li>*Patchwork applique circles</li> </ul>	<ul style="list-style-type: none"> <li>*Braiding/plaiting</li> <li>*Pintuck</li> <li>*Weave</li> <li>*Ruffles</li> <li>*Patchwork in strips</li> </ul>	<ul style="list-style-type: none"> <li>*Embroidery</li> <li>*Chain making</li> <li>*Hand stitching</li> <li>*Pleating</li> </ul>	<ul style="list-style-type: none"> <li>*Inserted zip from the original neoprene wetsuit for functionality</li> <li>*Hand stitch</li> </ul>	<ul style="list-style-type: none"> <li>*Pom poms</li> <li>*Ribbing</li> <li>*Fringing</li> <li>*Box pleats</li> <li>*Hand-knit</li> <li>*Hand sewn</li> </ul>	<ul style="list-style-type: none"> <li>*Used three different weight fabrics</li> <li>*Potato print</li> <li>*Plating</li> <li>*Hand sewn</li> </ul>	<ul style="list-style-type: none"> <li>*Patchwork</li> </ul>
Color Adaptation	<ul style="list-style-type: none"> <li>* Dye on the socks</li> <li>*Selected trousers and used the pattern</li> </ul>	<ul style="list-style-type: none"> <li>*Selected garments where colour complimented</li> </ul>	<ul style="list-style-type: none"> <li>*Selected ombre effect fabric</li> </ul>	<ul style="list-style-type: none"> <li>*Selected garments where colours worked</li> </ul>	<ul style="list-style-type: none"> <li>*Dyed yarns using avocado skins</li> <li>*Selected garments depending on the colour</li> </ul>	<ul style="list-style-type: none"> <li>*Selected garments depending on the color</li> </ul>	<ul style="list-style-type: none"> <li>*Selected garments where colours worked</li> <li>*PVC see-through fabric</li> </ul>
Notes	<ul style="list-style-type: none"> <li>*One sleeve is a trouser leg</li> </ul>	<ul style="list-style-type: none"> <li>*Focused on new surface ideas</li> </ul>	<ul style="list-style-type: none"> <li>*Used a variety of plastics</li> </ul>	<ul style="list-style-type: none"> <li>*Adjustable elements</li> </ul>	<ul style="list-style-type: none"> <li>*Functionality considered padding</li> </ul>	<ul style="list-style-type: none"> <li>*Tried everything first</li> </ul>	<ul style="list-style-type: none"> <li>*One sleeve is a trouser leg</li> </ul>

students' core wardrobe involves stretch garments. Therefore, it is imperative that they understand the differences in fabric types and construction. The design tutor mentions the module has fulfilled the aim as, overall, students improved their skills compared to the previous module. This module produced a variety of problem-solving approaches to work with stretch fabrics; however, the technical tutor raises how the upcycling element needed further embedding into the module content earlier on.

The upcycling method took a while for students to interpret the link between their design work and the element of upcycling within the module. Both tutors agree that students do struggle to blend the two practices. As the design tutor points out, this is on the same level as in other modules where students sometimes don't see the sessions being linked. The students' reaction to upcycling was mixed where some students felt a limitation in expressing their creativity whilst some enjoyed the limitations as it pushed their boundaries. This method of creativity challenged the traditional design and pattern cutting approach taught in the first year. The module made students try new design techniques and raise awareness of material value with a specific focus on the stretch. The technical tutor mentions stretch fabrics are a significant threat to the environment. When reflecting on the effectiveness of the content, it is again a difficult one to measure as students respond individually. However, there is a clear understanding this module has had a long-lasting effect, as conversations a year later showed. This evidenced that some students still stick to their changed consumer behavior and see opportunities in designing with a sustainable mindset.

Both tutors believe that specific content such as the FDC, closet mass index and question led report were effective tools to engage students. The FDC had a snowball effect on communities, households, and families the students inspired to get involved in the challenge. Therefore, some of this content is being taught to new first and second-year students as well as second-year students on the Fashion Branding and Communications

course. The design tutor believes the content has successfully raised awareness of the industry's negative environmental and societal impact through both analytical and critical design skills. The module delivered a broader perspective of the interconnectedness of design and consumption whilst looking at alternative approaches within the sphere of design and make. The design tutor would love to see the FDC taken forward with the combination of upcycling; however, the technical tutor sees stretch being taught as an essential addition to outfits, focusing on raising awareness of sustainable fabrics.

Both design and the technical tutor agree that the approach to embed sustainability into this module was successful. Even though the impact might be different amongst the students, the overall response was positive. The students have effectively taken their learnings on board, leading to further sustainable life changes. Finally, the design tutor mentions how the students now recognize the implications caused by the fashion industry and the role design plays to drive change towards a more environmentally friendly industry.

### 3) Summative Evaluations

After the students have completed the course or design, the summative evaluation would be used to figure out the learners' outcomes as well as the success of all the design components. These will be particular evaluation questions that ask students to rate the sessions and teaching performance (Aldoobi, 2015). Summative evaluation is carried out at three levels: (1) Perception – the level of learners' satisfaction, (2) Learning – knowledge and skill gained, (3) Performance – the use of newly acquired knowledge and skills (Branch, 2009).

#### (1) Perception – the Level of Learners' Satisfaction

Overall students evaluated the teaching both on-campus and online were satisfactory. Most of them took into consideration of Covid-19 restriction of teaching delivery and evaluated the teaching methods positively. However, a few students also reported that there was a miscommunication between online and on-campus sessions, and the project briefing for manufacturing the



final outcome was not clearly given. Students provided positive feedback about one-to-one tutorials given online sessions regarding design development. Online sessions help to enhance the virtual campus feel as Bates (2005, p. 44) addressed “video-conferencing is a good example of asynchronous technology. Although the learner may be distant from the teacher, both teacher and learner must be present at the same time”.

As for feedback about the level of difficulty for teaching contents and delivery, it was evaluated as adequate to follow. The tasks given each week helped students manage their time for work, however, each week of different tasks at the beginning from design and making sessions caused confusion about what the final outcome would be. The tutors’ accessibility was evaluated positively for both online and on-campus sessions. There is a complaint about the layout of the module page online saying finding sources is difficult. Students evaluated that the PowerPoints contents were easy to follow and the amount of information on each slide was appropriate. Using a Padlet was determined as an efficient tool to communicate between learners even though the number of posting requests was found challenging. Students commented that they enjoyed knowing how others were doing tasks and teaching each other as a team.

#### (2) Learning – Knowledge and Skill Gained

At the beginning of design sessions, counting students’ own garments in their wardrobe has been found relevantly impactful by providing the opportunity to consider ethical consumption. In general, a critical number of students responded that the sustainable fashion elements given impacted their design and garment manufacturing process. The sustainable fashion design consideration pushed students to design process turned into more eco-friendly/ environmentally friendly design, and upcycling and fabric manipulation techniques made students produce creative and innovative fabric and final outcomes. Students’ feedback about draping on the stand in the technical session was relevantly positive. The technique was used at the initial design stage by providing silhouette decisions, fabric applications, and

design idea testing. Students enjoyed playing around with different trials on stand translated into the final design. Upcycling during garment construction was evaluated as interesting but also challenging. Most of the students found upcycling in the pattern cutting stage was difficult especially when they applied zero waste techniques compared to traditional pattern cutting methods as well as when they had limited fabric was allowed

#### (3) Performance – the Use of Newly Acquired Knowledge and Skills

When asked students if they would use the acquired knowledge and skills, most of them mentioned that they would use them for the final year design and making projects, especially methods of fabric created by the application of recycling materials and textile embellishment techniques be used for future projects. This project’s overall design and development process not following the traditional way of garment design and manufacturing was considered a students’ future use. Students addressed the value of stand work and further application of zero waste techniques, including modular fashion for future garment construction. There were also potential further usages of Padlet to share ideas and a strong passion for using more CAD and Adobe Illustrator skills. In addition, a considerable number of students also mentioned that they would use the topic related to fashion sustainability for their final year of dissertation.

## V. Conclusion

Combining sustainable fashion within HE is securing the students with future proof knowledge to overcome issues presented within the industry with a variety of solutions. As creatives, the students need to become confident problem solvers. Many HE courses worldwide are building sustainable fashion education within their whole courses as it is imperative to make sure the students are taught the skills to help improve the industry as well as their own success. Embedding sustainability into the course is a responsible action by the educators to ensure the design students are employable when they graduate.

With the increase in specialist sustainability roles within the industry sector, this new knowledge allows the students to have a more significant chance of success after HE.

## 1. Major Findings

This research has developed the module curriculum with the aim of building students' knowledge about sustainability and stretch fabric. The module has been developed followed by the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. The results of this study demonstrate the overview of sustainable fashion design module construction, process, and evaluation. The findings reveal the considerable impacts on how students find design ideas during FDC and research into sustainable fashion in the design sessions and upcycling and textile development with consideration of stretch fabric in technical sessions.

The Analysis phase researched students' background, skills and knowledge learnt from the first year, then the topic of the module focused on sustainable design/materials/ construction technique was decided. By presenting the students with just 1 of the 17 SDGs (12) was an effective way of building upon the scaffolded learning theory efficiently within the module. This worked to empower the students with skills to work towards reflecting upon their own consumption and their individual production patterns compared to industries mass production patterns. With relevance to their own lifestyle and consumer habits, the focus on stretch fabrics helped bring to life the project especially during the Covid-19 pandemic where athleisure became a leading trend. As students researched firsthand into their own buying habits, their wardrobe and favorite garments to understand the process and means of making such garments and the actual value of a garment firsthand.

The Design phase determined learning objectives in design and technical elements for gaining relevant knowledge to achieve the module aim. In addition, the assessment requirements for each design and technical session have been decided with session time in a total of

eight weeks.

The Development phase focused on interacting with students with the appropriate content and instructors' innovative teaching delivery. Uniting the two teaching approaches: learning by doing and scaffolded learning complemented the practical course as step-by-step students were presented with obstacles to overcome through trial and error.

The Implementation phase addressed the importance of training instructors before the sessions and organizing the learning environment. Due to potential needs for online teaching with its benefit of flexibility and accessibility, the consideration of how to improve consistency between online and on-campus sessions and provide quality content was required. Technology improvement offered the tutors a better way of teaching students.

The Evaluation phase looked at students' final outcomes and analyzed the tutors and students' feedback. By reflecting upon their own individual outcomes, the students resolved the issues which challenged their original comfort zone and progressed them into the next phase of Vygotsky's ZPD. This helped to develop students who as Dewey mentioned are passionate, dedicated, politicized creatives who will work towards creating an environmentally friendly industry taking into consideration the needs of the greater good to help rebuild a better quality of life for society. Students are also requested to have a better understanding of the fabric properties that acted as a key to sustainable design development.

The findings show the creative investigation of upcycling of textile development, and students were challenged to think innovatively of a new solution for sustainable fashion design. The instructors in this module found the module delivery was considerably successful based on the impact on students gaining specialist knowledge of sustainable fashion and future plans to progress them. Students also evaluated the module contents and performance of teaching were satisfactory and demonstrated their improvement on the topic.

The application of knowledge and findings from this research would be recommended to adopt by the

instructors in HE for sustainable fashion curriculum development. Further study with applications other SDG goals and sustainable design and manufacturing approaches should be considered.

## 2. Limitation of the Research Study

As this research was a case study of one university's Fashion design module, its scope could be narrow to provide results that could be generalized, however, the findings of the study may claim fashion design educators to integrate the knowledge from this study in their teaching to help students develop a high level of design thinking and problem-solving skills necessary for sustainable fashion design practice.

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