

## EDUCATION ON SUSTAINABLE TEXTILE TECHNOLOGIES AND FASHION IN THE EUROPEAN MARKET

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**Abstract.** It is widely recognized that Education for Sustainable Development (ESD) plays a critical role in creating a more sustainable world by fostering the development of the knowledge, skills, understanding, values, and actions necessary for such change (UNESCO, 2020). In this context, ESD represents a holistic approach that focuses on lifelong learning to create informed people who can make decisions today and in the future. Related to the textile and fashion industry, ESD is an appropriate approach to continuously implement sustainability aspects in education and training. To achieve this goal, the European project "Sustainable Fashion Curriculum at Textile Universities in Europe - Development, Implementation and Evaluation of a Teaching Module for Educators" (Fashion DIET) has developed a digital teaching module in a partnership between a University of Education and universities with textile departments. The main objective of the project is to elaborate an ESD module for university lecturers in order to introduce a sustainable fashion curriculum in textile universities in Europe and implement it in educational systems. The project therefore aims to train educators along the textile supply chain, to inform the young generation about the latest aspects of sustainability and raise awareness by implementing ESD in textile education. This paper presents the learning outcomes of the modules on sustainable fashion design and related production technologies developed by the technical university partners, as part of the total of 42 courses covering didactic-methodological approaches and the sustainable orientation of the fashion market, offered at the consortium level. The project content is made available as Open Educational Resources through Glocal Campus, an open-access e-learning platform that enables virtual collaboration between universities.

**Keywords:** textile, education, sustainability, e-learning.

### 1. INTRODUCTION

The EU strategy strengthens industrial competitiveness and innovation in the textile and clothing industry. This in turn will boost the EU market for sustainable and recyclable textiles, including the market for textile reuse, tackle fast fashion and promote new business models [1] by:

- developing eco-design measures to ensure textile products are suitable for the circular economy;
- ensuring the use of secondary raw materials;
- combating the presence of hazardous chemicals;
- enabling businesses and private consumers to choose sustainable textiles and easy access to reuse and repair services.

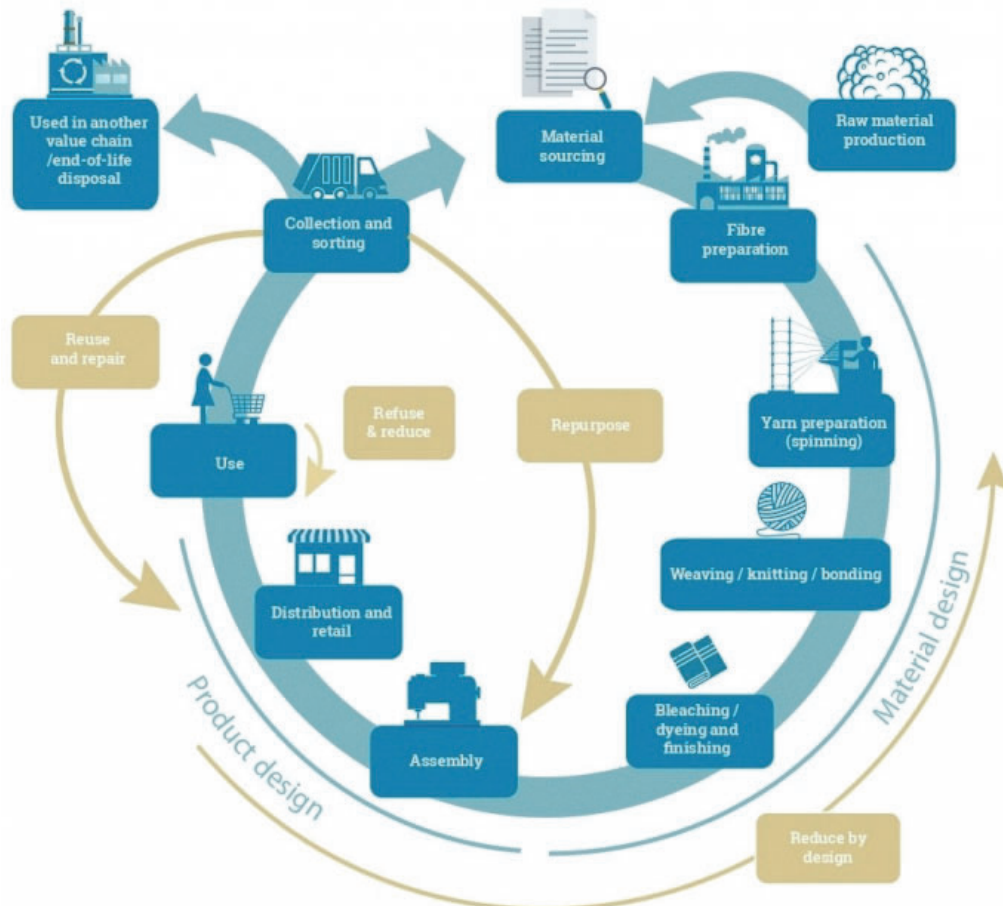
To meet the demands of industry, academic communities must develop a curriculum that is guided by the concept of sustainability. There is a need to discover and integrate knowledge, issues, perspectives, and values relevant to sustainable development: in the environment, society, and the economic system [2].

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has launched an initiative "Education for Sustainable Development" (ESD), which means a reorientation of the industrial

model of education, with significant educational implications for the cultivation of knowledge, skills and values structured to support sustainable development [3].

The future of the fashion, textile and apparel industry is based on the principle of sustainability. Sustainable textiles must be environmentally friendly and should meet rational conditions to maintain social and environmental quality by avoiding pollution or installing pollution prevention technologies [4].

The growing trend of sustainable and ethical designed textiles and garments contributes to a greener planet and creates a new job market (Figure 1) [5].



**Figure 1.** UN environment programme, sustainable and circular textile [5]

Sustainable design as part of education can give us a great advantage in business, while learning sustainable practices at the beginning of technology gives us an aggressive advantage and promotes eco-design.

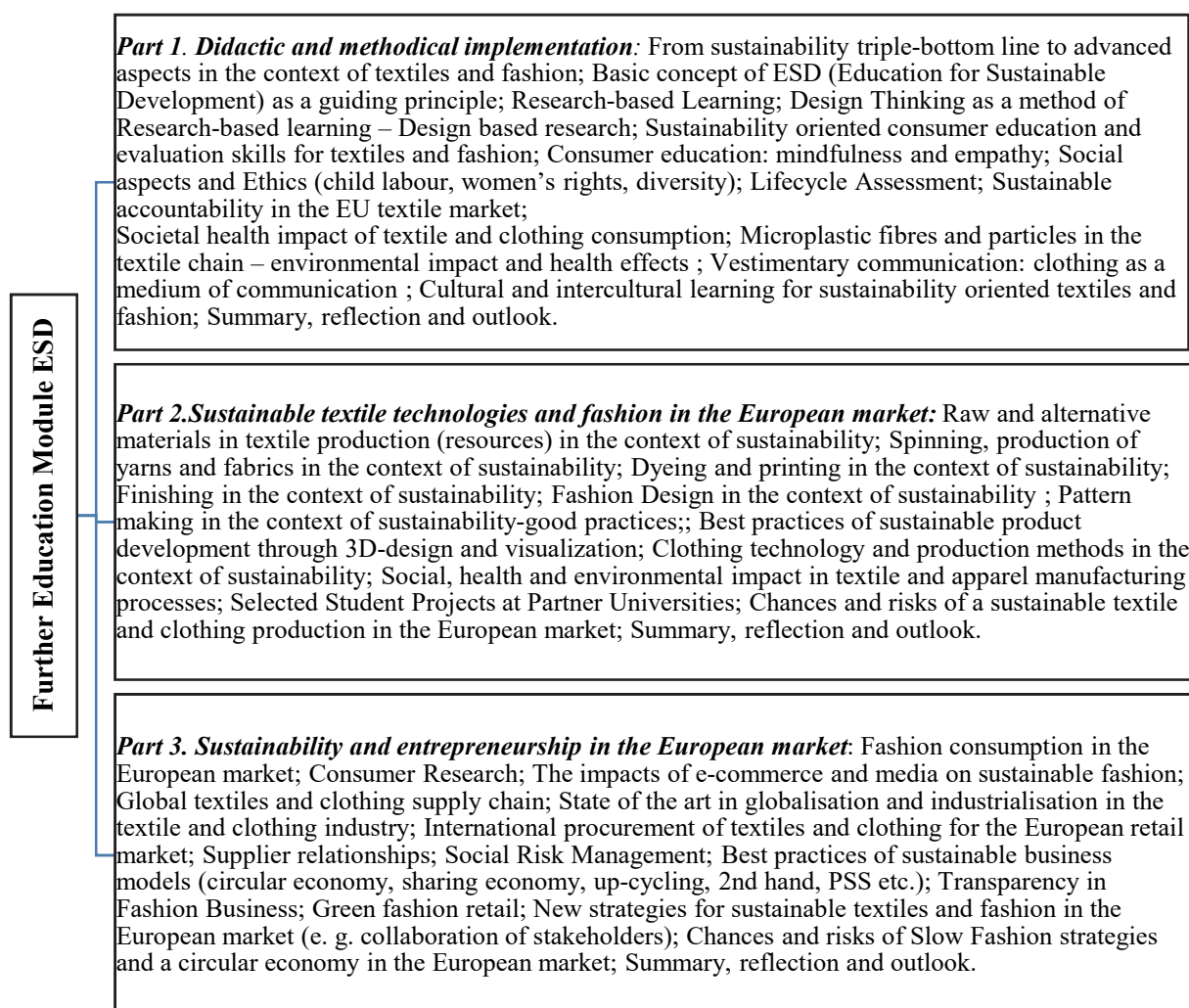
Education is one of the best places to initiate and develop the changes needed in these times.

## 2. FASHIONDIET EU PROJECT

The research project, ‘‘Sustainable Fashion Curriculum at Textile Universities in Europe, Development, Implementation and Evaluation of a Teaching Module for Educators’’, acronym FashionDIET, co-funded by the Erasmus+ programme of the European Union, is intended to elaborate an ESD module for university lecturers in order to introduce a sustainable fashion curriculum in textile universities in Europe and implement it in educational systems.

The project therefore aims to train educators along the textile supply chain, to inform the young generation about the latest aspects of sustainability and raise awareness by implementing ESD in textile education [6].

Based on research in the countries of the consortium project (Germany, Romania and Bulgaria), the team developed learning/training materials on didactic-methodological concepts, sustainable fashion design and production technologies, and the sustainable orientation of the fashion market.



**Figure 1.** Further Education Module ESD [6]

This paper presents the learning outcomes of the modules on sustainable fashion design and related production technologies developed by the technical university partners as part of the total of 42 courses covering didactic-methodological approaches and the sustainable orientation of the fashion market, offered at the consortium level.

### **3. LEARNING OUTCOMES OF SUSTAINABLE TEXTILE TECHNOLOGIES AND FASHION IN THE EUROPEAN MARKET MODULE**

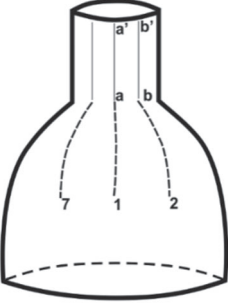
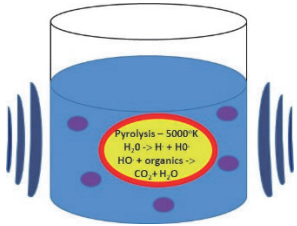
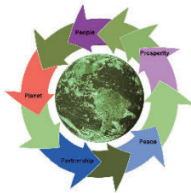
As shown in Figure 1, the topics related to sustainable textile technologies and fashion in the European market were developed in the continuing education module ESD, Part 2, with lectures on the main pillars of textile production. This part reflects the expertise in research and teaching at the universities in Romania and Bulgaria.

Table 2 summarizes the main learning objectives and outcomes of each educational module.

The content of the modules is available as Open Educational Resources through Glocal Campus, a freely accessible e-learning platform that enables virtual collaboration between universities.

**Table 2**

Learning objectives of the educational modules related to the sustainable textile technologies and fashion in the European market

Title of the educational module	Main purpose	Learning objectives
<p><b>Production of knitted fabrics in the context of sustainability</b></p>  <p><b>Figure 2.</b> 3D shaping [7-8]</p>	<p>The knitwear industry can make an important contribution to energy conservation, waste reduction, and emission minimization to meet environmental standards’.</p> <p>Selection of sustainable raw materials for knitwear production, use of energy efficient technologies, minimization of emissions, use of eco-friendly chemicals, prevention of emissions and minimization of waste are the concepts that need to be followed.</p> <p>The modules outline the main aspects of sustainability in knitwear production, focusing on sustainable methods of knitting on electronic flat knitting machines for reduction in labour, cost, time, environmental load, minimum possible level of disposal of waste, reduced requirement of fibre and yarn (Figure 2).</p>	<ul style="list-style-type: none"> <li>- Get knowledge on the principle of knitting;</li> <li>- Define the sustainable aspects of knitting technology; <ul style="list-style-type: none"> <li>- Provide information on sustainable raw materials for knitting;</li> <li>- Understand the sustainable methods on electronic flat knitting production;</li> </ul> </li> <li>- Present digital solutions from the knitting industry.</li> </ul>
<p><b>Dyeing and printing in the context of sustainability</b></p>  <p><b>Figure 3.</b> The sonolysis of the wastewater [9]</p>	<p>In the field of textile chemical processing, the problems are numerous, they being associated with the vast majority of specific processes, but among them of special attention are those related to the presence of dyes in wastewater from dyeing, and in connection with it, the possibilities of wastewater recirculation. Ecological design has gained significant significance over the last ten years, with increasing awareness of environmental issues in industry.</p> <p>This new approach started from the finding that the impact of a technology on the environment is largely determined by the choice of materials used and the way in which the products made are used and then made available, by reintegration into the environment (Figure 3).</p>	<ul style="list-style-type: none"> <li>- Understand the main issues related to sustainability in textile dyeing and printing; -Know the sustainability issues associated with the use of textile dyes;</li> <li>- Find out about the possibilities of optimizing existing technologies and replacing environmentally aggressive products;</li> <li>- Learn about the revolutionary new printing and printing technologies that are environmentally friendly.</li> </ul>
<p><b>Finishing in the context of sustainability</b></p>  <p><b>Figure 4.</b> Framework for sustainable finishing [10]</p>	<p>Textile finishing is a way to add new functionality to the fabric so that it becomes suitable for uses that are not normally accessible. Increasing the sustainability of textile finishing processes takes place on two levels: the substitution of environmentally friendly products, and the development of new environmentally friendly technologies.</p> <p>New techniques and practices related to textile finishing have been developed to eliminate the harmful effects of chemicals that either are used in finishing processes or are released as a by-product.</p> <p>The chemical finishing is expected to accentuate the tendency to use more sophisticated chemical finishes, which are more environmentally friendly and are specially formulated for ease of application on automatic machines and equipment (Figure 4).</p>	<ul style="list-style-type: none"> <li>- Understand the main issues related to sustainability in textile finishing;</li> <li>- Understand the sustainability issues associated with the use of textile auxiliaries;</li> <li>- Identify the possibilities of optimizing existing technologies and replacing environmentally aggressive products;</li> <li>- Apply the revolutionary new finishing technologies that are environmentally friendly.</li> </ul>

<p><b>Fashion design in the context of sustainable development of the fashion and textile industry</b></p>  <p><b>Figure 5.</b> Sustainable fashion collections</p>	<p>The wide-scale negative environmental and social impacts of the fashion industry are well known. In order to reduce these impacts, sustainable strategies and practices are more and more developed and implemented. Sustainability is a very complex phenomenon and approach, for which there is no single or general definition. The concept of sustainable fashion can include different strategies among designers to compete on the clothing market by creating, for example, alternatives to fast fashion. This module presents different sustainable concepts, approaches and practices in fashion and textile design, their particularities and importance in the future development of the industry (Figure 5).</p>	<ul style="list-style-type: none"> <li>- Understand the need of sustainable approaches;</li> <li>- Explain the meaning of sustainability, sustainable fashion and slow fashion;</li> <li>- Discuss the role of the fashion designers;</li> <li>- Describe new approaches in design, in the context of sustainability and the circular economy;</li> <li>- Reflect on the importance and challenges of education in sustainable design.</li> </ul>
<p><b>Best practices of sustainable product development through 3d-design and visualization</b></p>  <p><b>Figure 6.</b> Digital fashion [11]</p>	<p>Digital technology is increasingly present in daily life and will bring significant changes, improvements and also challenges. The digital approach to product development facilitates collaboration work platforms, virtual meetings, and automated processes. A digital alternative suitable for the fashion and apparel industry is 3D: virtual 3D prototypes, 3D visualisation, 3D body scanning, and virtual try-ons solve the problem of proper fit while avoiding bottlenecks in the supply chain. In this way, the apparel sector can achieve green goals without polluting the environment with wasteful manufacturing processes. This module provides general insight into product development using 3D methods (design and visualisation) that will help designers create exceptional items and improve efficiency in evaluating the creation of conceptual models to better support interactive design activities for apparel displays (Figure 6).</p>	<ul style="list-style-type: none"> <li>- Characterize the concept of sustainability and digitalization for fashion and textiles;</li> <li>- Describe the importance of digital innovation for a sustainable fashion and textile industry;</li> <li>- Characterize product development for the mass customization fashion industry;</li> <li>- Present sustainable solutions for product development - fashion and apparel industry;</li> <li>- Characterize digital clothing development;</li> <li>- Describe best practices of sustainable product development – fashion and clothing industry.</li> </ul>
<p><b>Selected student projects at partner universities (part 2)</b></p>  <p><b>Figure 7.</b> Pattern making for minimising waste</p>	<p>Previous topics about fashion design and pattern making in the context of sustainability introduce materials about the long-life fashion elements, the pattern making of slow fashion clothes, the sustainable proportions, and zero or minimizing waste pattern design. The sustainable fashion design is supported by sustainable proportion, as the more sustainable ones are based on the golden ratio and Fibonacci numbers. For more successful sustainable fashion design, the application of the long-life fashion elements, the correct pattern making, the sustainable proportions, and the possibilities for zero or minimizing waste can be combined. The presented students' projects on sustainable design and pattern making of women's clothes can be seen as examples for development of new ideas and creation of new slow fashion designs with different types of long-life elements, golden and Fibonacci proportions, minimizing waste, and combinations between them (Figure 7).</p>	<ul style="list-style-type: none"> <li>- Design clothing applying sustainable long life fashion elements: drapes, other 3D elements and peplums;</li> <li>- Design clothing using sustainable proportions, based on the golden ratio and Fibonacci sequence;</li> <li>- Make correct patterns of draped clothes using easy calculations;</li> <li>- Make correct patterns of 3D peplum dresses;</li> <li>- Create minimizing waste designs on the base on the golden ratio and Fibonacci sequence tilings.</li> </ul>

**Chances and risks of a sustainable textile and clothing production in the European market**



**Figure 8.** Framework for sustainable apparel [12]

The future of the fashion, textile and apparel industry is based on the principle of sustainability. Just as consumers are now taking a closer look at the food they consume and the chemicals they put in their bodies, they are also shifting their purchasing decisions to create a cleaner environment through the clothes they wear.

Some fashion brands are aware of their unsustainable practises, but it is not always easy for them to change. Nevertheless, growing consumer demand for ethical products is already forcing the fashion industry to adapt, as evidenced by the increasing number of campaigns promoting sustainable practises in the fashion industry.

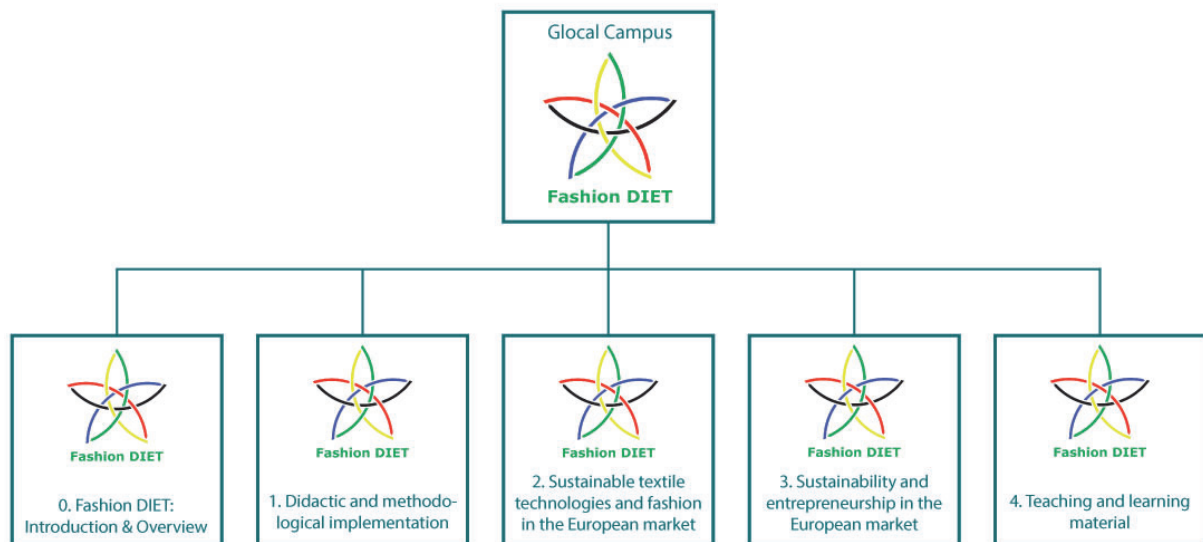
It is time for consumers to pay attention to their clothes, to learn more about where their clothes are made and by whom, to act responsibly, and to use their purchasing decisions to change the way manufacturers see them (Figure 8).

- Get in touch with the characteristics of the European textile and clothing industry;
- Describe the challenges in the European textile and clothing market;
- Describe the threats in the European textile and clothing market;
- Present the principle of sustainability in textile and clothing production.

**4. E-LEARNING ENVIRONMENT**

The project content will be made available as Open Educational Resources through Glocal Campus, a Moodle platform resulted from a joint project of the University of Jena, Bauhaus University Weimar and Ilmenau University of Technology. Glocal Campus is an international collaborative workspace with 90 member universities from 30 countries and offers 500 courses [13].

The Project Fashion DIET has five so-called course rooms (Figure 12) on the Glocal Campus: Fashion Introduction & Overview (about the project; structure of the information and e-learning portal; navigation guide); Didactic and Methodological Implementation (ESD Module 1; 14 lectures); Sustainable Textile Technologies and Fashion on the European Market (ESD Module 2; 14 lectures); Sustainability and Entrepreneurship on the European Market (ESD Module 3; 14 lectures); Teaching and Learning Materials.



**Figure 12.** Structure of FashionDIET on the Glocal Campus [13]

Each course room is divided into 14 lectures, which can be found on the left side in the green navigation bar (Figure 13). Each lecture is divided into the following four subsections: Lecture learning objectives; Lecture PowerPoint presentation; Lecture pdf document; and Downloads.

ESD Module Part 1: Overview

- Topic 1: From Sustainability Triple-Bottom Line to Advanced Aspects in the Context of Textiles and Fashion
- Topic 2: Education for Sustainable Development (ESD) as a Guiding Principle in the Context of Fashion and Textiles
- Topic 3: Research-Based Learning in the Context of Textile Education
- Topic 4: Design Thinking - a Suitable Method for Implementing Education for Sustainable Development (ESD) in Textile Education
- Topic 5: Sustainability Oriented Consumer Education in Fashion and Textiles
- Topic 6: Consumer Education: Mindfulness and Empathy
- Topic 7: Social Aspects and Ethics (e. g. Child Labour, Women's Rights, Diversity)

ESD Module Part 1: Overview

1. Didactic and methodological implementation

The ESD Module Part 1 "*Didactic and methodological implementation*" consists of the following 14 lectures:

1. From sustainability triple-bottom line to advanced aspects in the context of textiles and fashion
2. Basic concept of ESD (Education for Sustainable Development) as a guiding principle
3. Research-based Learning
4. Design Thinking as a method of Research-based learning – Design based research
5. Sustainability oriented consumer education and evaluation skills for textiles and fashion
6. Consumer education: mindfulness and empathy
7. Social aspects and Ethics (e.g. child labour, women's rights, diversity)
8. Lifecycle Assessment
9. Sustainable accountability in the EU textile market
10. Societal health impact of textile and clothing consumption
11. Microplastic fibres and particles in the textile chain – environmental impact and health effects
12. Vestimentary communication: clothing as a medium of communication
13. Cultural and intercultural learning for sustainability oriented textiles and fashion
14. Summary, reflection and outlook

ESD Module Part 1: Overview

Topic 1: From Sustainability Triple-Bottom Line to Advanced Aspects in the Context of Textiles and Fashion

From Sustainability Triple-Bottom Line to Advanced Aspects in the Context of Textiles and Fashion

The textile and clothing industry accounts for approximately \$3 trillion in global revenue and employs 300 million people along the value chain. Besides its economic power, the industry unfortunately generates detrimental impact on the environment due to its natural resource

Figure 13. Organisation of the modules content on the Glocal Campus rooms [13]

In addition, the Fashion and Textile Database was developed, a comprehensive database that collects current information on fashion and textile topics.

## 5. CONCLUSIONS

Education in the textile and fashion industry has changed to reflect the current concern for the environment, with the goal of reducing the environmental footprint of the apparel and textile industry, with each educational institute having sustainability as an integral part of its programme.

A multifaceted approach to sustainability in education is needed for students to consider new business models. This includes reinvention processes through leasing and service, consumer education through

marketing, raw materials and environmentally friendly manufacturing processes, recycling and circular processes, and ethical production practices.

The key to sustainable education is increased collaboration between industry institutes and companies focused on sustainability. There is no pattern to follow because the field is so vast, complex, and constantly evolving that industry, educational institutions, and educators are exploring different initiatives that can and should be implemented in different ways.

Sustainability initiatives are not an additional element but are part of the core of the fashion design process, and this should be reflected in education.

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