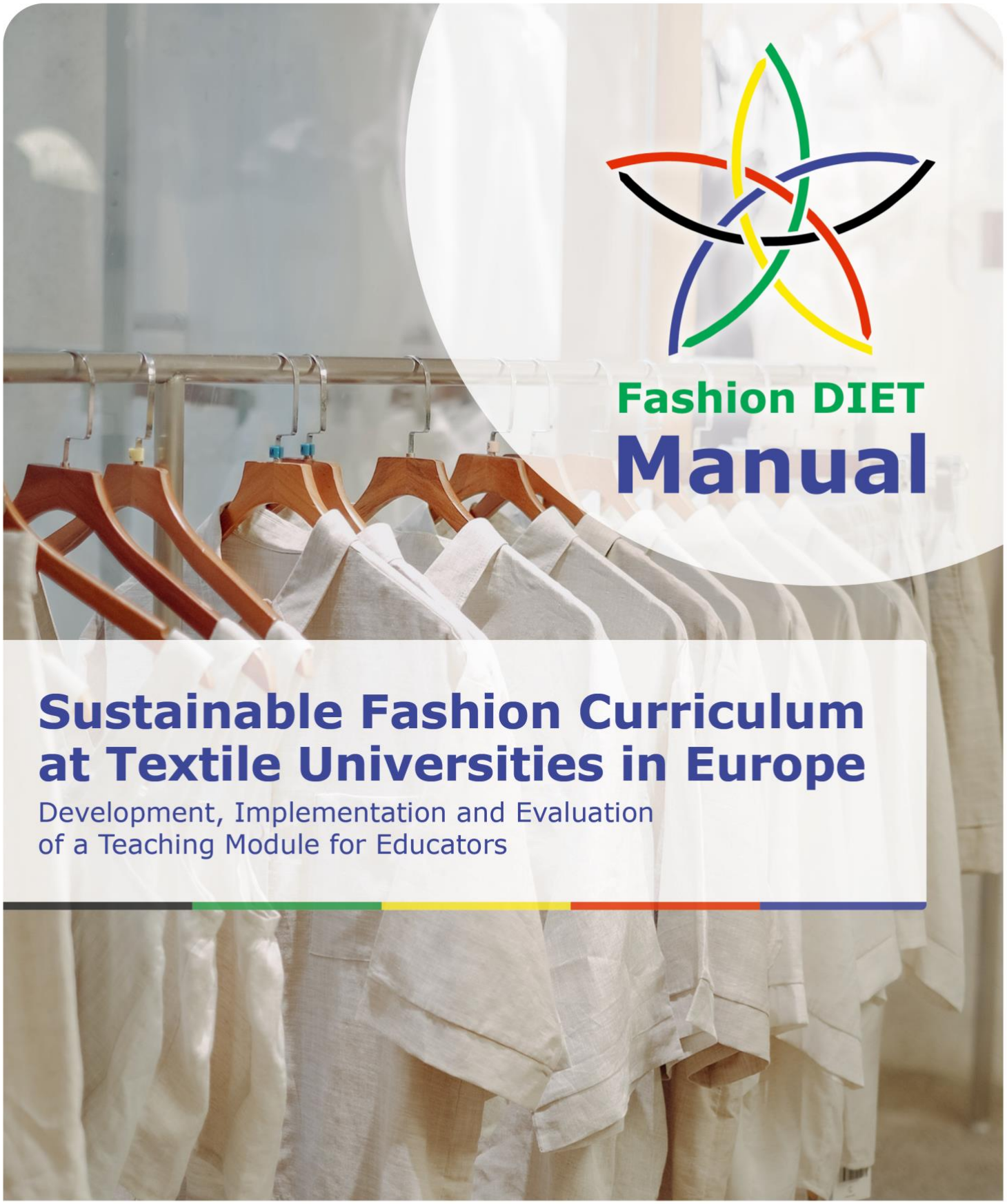

Fashion DIET

# Manual

# Sustainable Fashion Curriculum at Textile Universities in Europe

## Development, Implementation and Evaluation of a Teaching Module for Educators

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Co-funded by the European Union

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# Sustainable Fashion Curriculum at Textile Universities in Europe

## Development, Implementation and Evaluation of a Teaching Module for Educators

Pädagogische Hochschule Freiburg – University of Education Freiburg

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## PARTNER UNIVERSITIES

P1 University of Education Freiburg, Germany (Coordinator)
P2 Reutlingen University, Germany
P3 Gheorghe Asachi Technical University of Iaşi, Romania
P4 Trakia University of Stara Zagora, Bulgaria

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# 1 Preface

## 1.1 Short Overview

Fashion DIET (Sustainable Fashion Curriculum at Textile Universities in Europe – Development, Implementation and Evaluation of a Teaching Module for Educators) is an EU funded project under the Key Action “Strategic Partnerships” of the Erasmus+ Programme. From September 2020 until August 2023, the international project has been developing teaching and learning arrangements under the lead management of the University of Education Freiburg. Partner universities are Reutlingen University in Germany, Gheorghe Asachi Iaşi University of Technology in Romania and Trakia University Stara Zagora in Bulgaria.

The devastating environmental and social implications of the fast fashion and textile industry which prevailed throughout the last decades make it of high relevance to integrate the targets of the sustainable development goals (SDGs) of the UN into the entire textile value chain, i.e. production, consumption and disposal sites, to make it fully sustainable and positive for people and the ecosystems. The upcoming transformation of the textile and fashion industry towards sustainability therefore requires nothing less than a continuous implementation of the guiding principle Education for Sustainability Development (ESD) in education and training.

The Fashion DIET project aimed to foster the process of ESD implementation in national educational systems. The project’s major goal was to develop an ESD further education module in the context of fashion and textiles for universities since teachers and learners will have to cooperate more internationally in the future to establish the guiding principle of ESD permanently on an international level. Furthermore, teaching and learning material derived from this for vocational schools and secondary education has been developed and made available as Open Educational Resources (OER) via the database Glocal Campus.

## 1.2 Keywords

Education for sustainable development ESD, guiding principle, ESD module, textile and clothing technology, E-learning, curricula, open educational resources, web-based tool, fashion design

## 1.3 Acknowledgements

The authors would like to express appreciation for the co-funding of the Erasmus+ Programme of the European Union [Project “Sustainable fashion curriculum at textile Universities in Europe – Development, Implementation and Evaluation of a Teaching Module for Educators” / Erasmus+ Programme 2020-1-DE01-KA203-005657] by the NA DAAD.

## 1.4 Need and Timeliness of the ESD Module

ANNE-MARIE GRUNDMEIER AND DIRK HÖFER

The project partners conducted a qualitative-quantitative online questionnaire using Google Forms (Google Inc.) to define the attitudes and needs for contents and methods of university lecturers. The survey was conducted in three countries – Germany (DE), Romania (RO) and Bulgaria (BG) – in the official languages of the respective countries. A total of 122 respondents took part in it, of which 15% were men and 85% women. 92% of the participants responded as lecturers and 8% as PhD students and researchers or performing other types of activities.

According to the survey, the target group defined mutual as well as country-specific perspectives on the need and content of the ESD Module: In all countries, ecology is by far the most important factor followed by economic aspects in the second place and the social impact of sustainability. Hence, all three countries agreed that management-oriented needs and learning should be implemented in the curriculum with a strong and specific emphasis on the environmental impact of textiles and fashion. In addition, the target group asked for comprehensible teaching and didactic methods and an information and resource platform (data access). In all countries, the target group suggested to present the training and learning methods with a very strong demand for practical relevance, i.e., to use case-based learning and best practice (case) examples. However, a stronger demand for sustainable design was observed in Bulgaria, whereas in Germany the understanding of the role of the consumer turned out to be important for better education. Moreover, the importance of ecology strongly aligned in Germany with aspects of education, future orientation and responsibility, whereas in Romania ecology and economy predominated while Bulgaria rated aspects of ecology and culture to be very important.

Based on these findings, the authors valued the countries’ different perspectives, expectations and requirements regarding ESD (e.g., best-practice examples) and presented ESD in all of its facets. In that regard, the Fashion DIET project takes a strict holistic view on sustainability with respect to both the producer’s and the consumer’s side.

This systemic view is irrevocable as the steady increase of sustainable consumer behaviour leads companies more and more to strengthen their efforts to become socially and ecologically more sustainable.

By means of the first Learning, Teaching and Training LTT event at the Gheorghe Asachi Iaşi Technical University in the summer of 2021, the developmental status of the further education module was tested and evaluated by about 70 lecturers. Within the course of three days, presentations, workshops and feedback discussions took place, which covered the following topics:

- Introduction to the project's main goals and outcomes
- ESD as a guiding principle in the textile and fashion sector
- Selected aspects of sustainability and health in the textile chain
- Selected aspects of sustainable fashion design and textile technologies
- Sustainable textiles and fashion in the EU market with case studies of the partner countries
- Overview on sustainability and entrepreneurship in the EU market
- Working with the ESD Module
- Introduction to and working with the information & e-learning portal

The participants' feedback by means of group discussions and a questionnaire was used to revise the ESD module's content and methodology and to prepare content posting on the open information & e-learning platform *Glocal Campus* as in the future, teachers and learners must increasingly cooperate internationally in order to permanently establish the guiding principle of ESD on an international level. To enable this cross-university exchange of digital teaching and learning arrangements, the project content of Fashion DIET has been made available as educational material in virtual learning spaces via *Glocal Campus*, a Moodle-based online platform that has transformed into an international university network and enables virtual collaboration in a wide range of subjects, from architecture, medicine and education to intercultural studies.

Within the second LTT, carried out in April 2022 at the Trakia University of Stara Zagora Bulgaria, the project team gave a presentation about the "Current status of ESD Module - Goals and Intercultural Perspectives and Clashes". Within this presentation the team discussed the impact of intercultural differences between the three partner countries (see following section: Intercultural aspects in sustainable fashion education).

The module's content is the outcome of the latest advance in textile-related ESD and sustainability aspects of the four project partners.

## 1.5 Intercultural Aspects in Sustainable Fashion Education

JOCHEN STRÄHLE

In recent years, the fashion industry has come under scrutiny for its impact on the environment and society. Thus, the concept of sustainable fashion has gained popularity as a way to address these issues. In order to design, produce and market such sustainable fashion, the future generation of fashion professionals must be educated about the topic. However, sustainable fashion education must also take into account intercultural aspects as fashion is a global industry that involves different cultures, traditions and values. This introduction will explore the importance of intercultural aspects in sustainable fashion education and ways to integrate it into the curriculum.

Fashion is a form of expression that is deeply rooted in culture, history and identity. Clothing is often used to convey social, economic and political status, as well as religious and cultural beliefs. Therefore, sustainable fashion education must take into account the diverse cultural perspectives that exist in the world. It is important to recognize that sustainable fashion is not a one-size-fits-all solution since what is sustainable in one culture may not be sustainable in another.

Intercultural aspects in sustainable fashion education can be integrated in various ways. One approach is to include case studies that showcase sustainable fashion practices from different cultural perspectives. This allows students to understand how sustainable fashion can be achieved while respecting cultural values and traditions. For example, traditional weaving techniques can be used to produce sustainable fabrics in countries like India and Guatemala, where the textile industry has a rich cultural history.

Another approach is to invite guest speakers from different cultural backgrounds to share their experiences and perspectives on sustainable fashion. This allows students to gain a deeper understanding of the cultural factors that influence sustainable fashion practices. Guest speakers could be designers, artisans, activists and scholars from different parts of the world.

Intercultural aspects can also be integrated into sustainable fashion education through experiential learning opportunities. Study abroad programs and cultural immersion experiences allow students to engage with different cultures and gain a first-hand understanding of sustainable fashion practices in different contexts. This can be particularly valuable for students who are interested in pursuing careers in the global fashion industry.

One of the challenges of integrating intercultural aspects into sustainable fashion education is the lack of diversity in the fashion industry. The industry is still dominated by

a few Western countries and lacks representation from other parts of the world. This can make it difficult to find examples of sustainable fashion practices from diverse cultural perspectives. Therefore, it is important to seek out and amplify the voices of designers, artisans and activists from underrepresented communities.

Intercultural aspects in sustainable fashion education can also help to address issues of cultural appropriation. Cultural appropriation occurs when elements of a culture are taken and used without permission or understanding of their cultural significance. Sustainable fashion education can play a role in educating students on the importance of cultural sensitivity and respecting cultural traditions. For example, sustainable fashion designers can collaborate with artisans and communities to create sustainable products that respect and celebrate cultural traditions.

In conclusion, intercultural aspects are an important component of sustainable fashion education. Fashion is a global industry that involves diverse cultures, traditions and values. Sustainable fashion education must take into account the cultural perspectives that exist in the world in order to create meaningful and effective solutions to the environmental and social issues facing the industry. Integrating intercultural aspects can be done through case studies, guest speakers, experiential learning opportunities and amplifying the voices of underrepresented communities. It is important to recognize the diversity of sustainable fashion practices and to approach sustainable fashion education with cultural sensitivity and respect.

## 1.6 Appropriateness of Content of Materials / Topics for Target Audience

ANNE-MARIE GRUNDMEIER AND DIRK HÖFER

The Fashion DIET project envisages the development of new tools for improving key competences of lecturers, teachers, trainers, students and young textile specialists. The target group therefore comprises students and vocational scholars and continuing education scholars, guided by academic teachers.

- Content level is appropriate for persons who are involved in vocational education and training as well as higher education, i.e., at graduate or continuing education level. Because of the wide variety of professions, some of the graduate level or continuing education levels will have more background knowledge and prior understanding on sustainability than others.
- Content is useful from the viewpoint of an academic.

- Because there is a wide variety of potential users of the ESD module who have divergent (cultural/academic) backgrounds, it is important that foundational/basic information is included in the introductory sections and then mentioned or applied later on throughout the module. This complies with Bruner's (1977) spiral curriculum – an approach to education that involves a regular revising of the same educational topics over the course of a student's education.
- The materials can be useful for academic teachers in order to guide scholars, graduate or continuing education students through the ESD module.
- Finally, there are suggestions for organisers and lecturers regarding the ESD module: structure and content, organisation, learning methods, expected outcomes and competencies, target groups and documentation. The lectures are intended by the authors as learning offers for teachers and not as ready-made lectures.

## 1.7 Obtaining Documentation and Information

### 1.7.1 Internet

The latest version of this documentation is available at the major project website.
Link to Fashion DIET website:
https://fashiondiet.eu

The teaching and learning arrangements are provided as Open Educational Resources under the web address:

Link to Glocal Campus:
https://glocal-campus.org/login/altlogin/index.html

A comprehensive and systematic database for collecting current information on fashion and textile topics has been established. It can be found under the following web address:

Link to F+TD:
https://opus.bsz-bw.de/ftrc/home

### 1.7.2 Documentation Feedback

If you are reading the present documentation on the internet or at the platform *Glocal Campus*, any comments on the ESD Manual can be submitted on the support website https://fashiondiet.eu. We appreciate your comments.

### 1.7.3 Style Conventions

The following style conventions are used in this document:

**Bold**
Titles and subtitles

*Italic*
Emphasis (for example a new term)

Variables
URLs, complete paths, filenames, prompts, and syntax
User input variables
[ ] Square brackets surround optional items such as translations

**Reference Style: APA 7th Referencing**

# 2 Introduction

## 2.1 Introduction to Sustainability and ESD

ANNE-MARIE GRUNDMEIER AND DIRK HÖFER

The UN World Conference on the human environment in Stockholm (UN General Assembly, 1972) is considered the beginning of the international environmental policy on sustainability. Basically, the idea of sustainability was verbalised by Schumacher (2019) as 'permanence', where nothing makes economic sense unless its continuance for a long time can be projected without running into absurdities.

In 1983 the World Commission on Environment and Development was established. The result of their work was formalised in the 1987 Brundtland Report 'Our Common Future' (Brundtland, 1987), which highlights the threat of the needs of future generations. That means resources should only be used to the extent they can be regenerated. Furthermore, there should be equal opportunities for every human being on earth, which means that industrial countries need to stop living at the expense of people in the Global South. The Brundtland Report defined sustainability as a "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, p. 37), in particular the essential needs of the world's poor and future needs.

Based on the recommendation of the Brundtland World Commission, the United Nations Conference on Environment and Development was then called in Rio de Janeiro in 1992 and is considered one of the political highlights in the history of sustainable development (Grunwald & Kopfmüller, 2012, p. 26). The aim of the assembly was also to achieve equal opportunities for everyone on the planet so that people in industrialised countries do not continue to live at the expense of people in developing countries. The Rio Summit in 1992 came up with the Agenda 21 (United Nations, 1992), which compelled the participating countries to act in a sustainable manner. From then on, sustainability was understood as a development concept that is geared towards the long-term, dynamic self-preservation of societies in ecological, economic and social terms in which sustainable development has to be a guiding principle.

Another milestone in sustainable development was the United Nations Summit on Sustainable Development in September 2015 (United Nations, 2015), where the 2030 Agenda for Sustainable Development was adopted by all member states. In order to protect the planet from deterioration, the key development goals include sustainable consumption, sustainable production, sustainable management of natural resources and

immediate action against climate change. Thus, Agenda 21 clarified that people, the planet, prosperity and peace are at the forefront of sustainability.

It is widely accepted that the textile and clothing industry has not taken care of sustainable developments for many decades (Bick et al., 2018; Boström & Micheletti, 2016; Köksal et al., 2017). The sector has seen spectacular growth, i.e., from an economic perspective, the textile and clothing industry accounts for approximately $3 trillion in global revenue and employs 300 million people along the value chain, providing people with clothing, shoes, carpets, curtains, furniture, etc. for homes, offices and public buildings. However, besides its economic power, the industry unfortunately generates detrimental impacts on the environment due to its natural resource consumption, the generation of greenhouse gases and environmental pollution. Additionally, human rights issues within the production of clothing and textiles generate serious social and economic sustainability problems. Fortunately, current industry activity responding to the sustainability challenges suggests a growing commitment to sustainable practices (Boström & Micheletti, 2016). So, while the environmental, social and economic consequences associated with the clothing and textiles supply chain are serious, there are promising signs that a significant paradigm shift towards sustainability is gaining momentum. To reach this conversion, the sustainable clothing and textile industry is currently based in many cases on the triple bottom line concept (TBL). This concept was originally defined by the Brundtland Commission and describes a sustainable development by taking all stakeholders into account. The TBL concept comprises an accounting framework with the three dimensions: social, environmental and financial. The concept in the clothing and textiles supply chain turned out to be a universal method for building economic, social and environmental resources while fostering sustainable livelihoods by balancing these three factors.

Despite the shift towards sustainable development, it soon became clear that the textile and clothing industry would not be able to achieve the necessary transformation on its own. Rather, it turned out that the upcoming transformation of the textile and clothing industry towards a sustainable textile value chain places responsibility on all actors in the industry and on consumers as a change needs skilled workforce as well as educated, informed consumers. This requires nothing less than closing the obvious knowledge gaps and developing the needed skills and competencies across all actors.

It is widely accepted that Education for Sustainable Development (ESD) plays a crucial role to create a more sustainable world by promoting the development of the knowledge, skills, understanding, values and actions that are required for this transformation (UNESCO, n.d.-a). Encouraged in the Agenda 21 of the United Nations Conference on Environment and Development in 1992 and followed by the United Nations, the pivotal goal of ESD is a change in society towards more sustainability. Thereby ESD denotes a

holistic concept that is geared towards lifelong learning, a target that goes hand in hand with the Sustainable Development Goal (SDG) no. 12 according to which only informed people can make well-founded decisions today and in the future (Federal Ministry of Education and Research Germany, 2017). Related to the textile and fashion sector, ESD is an appropriate approach for continuously implementing sustainability aspects in education and further education.

For its realisation, the UNESCO's Executive Board recently launched the Roadmap ESD for 2030 (UNESCO, 2020, p.30) which sets out the urgent challenges facing the planet and underlines the implementation of ESD. Basically, the ESD roadmap aims to reorient and strengthen education and learning to contribute to all activities that promote sustainable development. In particular, it outlines actions in five priority action areas on policy, learning environments, building capacities of educators, youth and local level action, stressing further ESD's key role in the successful achievement of the 17 SDGs and the great individual and societal transformation required to address the urgent sustainability challenges. Taking a closer look at the roadmap's field of action of teachers' competence development, it becomes apparent that ESD is not a task of a single field of study, but an interdisciplinary approach that requires a subject-specific connection (Singer-Brodowski et al., 2019, p. 126; Blaga et al., 2022). In this way, the concept of ESD is a challenge for the contents, didactics and methodological approaches of a wide range of studies.

Although the importance of an ESD that empowers students to engage with real societal problems to promote a sustainable future is widely acknowledged, the content and tools of universities in implementing an ideal or normative concept of ESD have received little attention. In order to transform the textile and fashion industry into a sustainable textile value chain, a continuous implementation of the guiding principle of ESD is needed – not only in education but also in the industry (Grundmeier, 2017; Fletcher & Williams, 2013; UNESCO, 2020). Such a paradigm shift requires extensive new knowledge on the part of both industry and trade, as well as consumers. This very requirement reveals that university lecturers as well as trainers in companies and teachers are not yet sufficiently sensitised and didactically and methodically trained to implement ESD in education and further education of the textile and fashion sector. Therefore, in the first step lecturers, teachers and educators who want to deal with sustainability issues, need specific knowledge and skills. Furthermore, innovative teaching and learning materials should be provided in order to promote their ESD competencies.

## 2.2 Purpose of the Project

ANNE-MARIE GRUNDMEIER AND DIRK HÖFER

In order to achieve the SDGs and establish sustainability as a principle in all sectors and areas of society, we need education as a pivotal element of change. Due to its long-standing take-make-waste economy, there is a strong demand for sustainability in the textile and fashion industry and its global market. The demand imposes a continuous and urgent implementation of the guiding principle Education for Sustainable Development (ESD) in education and industry. As insufficient teacher education and teacher training are regarded as a key barrier for the actual implementation of ESD, the goal of the project was to envisage the development of new tools for improving key competences of lecturers, trainers, teachers, students and young textile specialists with the following three Intellectual Outputs:

1. Further Education Module
2. Information & E-Learning Portal
3. Teaching and Learning Material.

As a first step, a Further Education Module was established in order to implement ESD as a guiding principle into university lectures on an international level. This manual encompasses the content of the first Intellectual Output. Based on a survey of over 120 university lecturers in all three partner countries the project team developed a three-part further education module on ESD in the textile chain. It includes didactic-methodical concepts, sustainable fashion design and production technologies as well as a sustainable orientation of the fashion market. In the summer of 2021, the ESD module was tested and evaluated for its further training status by 70 participants from the partner countries at a three-day Learning, Teaching and Training (LTT) online event.

In terms of content, both production and consumption are examined from an ESD perspective. This interdisciplinary perspective is new for engineering courses of study that focus on production and the respective production stages. The content of the module is structured according to a modular system. A teaching unit with a workload of 6 ECTS has been developed jointly, which can be used for further education of lecturers, trainers and teachers or as didactically and methodologically prepared lecture contents. Units are pragmatically structured and in digital form to be helpful for the mentioned target group. Each of these three teaching units considers the country-specific conditions of the textile and fashion industry and fashion trade. The module's objectives are:

- Enhancing the quality and relevance of the learning offer in ESD by proposing new and innovative approaches.

- Fostering the development of ESD competences.
- Increasing labour market relevance of the learning material.
- Reinforcing links between education, research and the industry.

The module's content is the result of the latest advance in textile-related ESD and sustainability aspects of the four project partners. The state-of-the-art research results and methodology for education hopefully contribute to a good orientation and guidance for lecturers, trainers and teachers in textiles and fashion, but also students and young trainees.

## 2.3 Overview of ESD Module

ANNE-MARIE GRUNDMEIER AND DIRK HÖFER

Open Educational Resources (OER) remarked enormous use in the field of education that all the levels of education like primary, secondary, higher secondary and higher education, professional education, technical education and even in the field of research. Those resources help us in teaching, learning and research materials, that exist in the public province or are released under an open license that permits no-cost access, adaptation, use, and reorganization by others with no or limited restrictions (UNESCO, n.d.-b). Hence, in a competitive education world, more and more institutions and individuals are sharing digital learning resources over the internet openly and without cost (Kirschner et al., 2006). The Fashion DIET project strictly follows this trend. As the project's holistic approach faces a quite diverse target group encompassing lecturers, educators, teachers and vocational trainers, all 42 ESD courses have been designed by the authors, rather than created as classic (pre-made) "lectures".

All courses are developed as Open Educational Resources and thus deliver learning and teaching materials with either specific content or an overview that can be adapted by the target group. The aim is not to change existing study regulations, but rather to enable teachers to decide for themselves whether to use the content or to learn with the content themselves. According to this, the courses can more or less be seen as suggestions or proposals of content on the respective topic. However, the authors of the ESD module strongly recommend that the content should always be given with an appropriate didactic reduction. Each educator is invited to adapt the content to the needs of the respective learning group.

The teaching and learning arrangements are provided as OER on the open access e-learning platform Glocal Campus for research-based teaching and learning at vocational and secondary schools. From a teaching perspective, the e-learning approach is known

to offer comparably pedagogical and practical benefits to all participants in a supply chain (Gunn, 2010). This includes lecturers, students and employees in the textile and fashion industry. Since the first occurrence of e-learning in the mid-1990s, this technology has been widely used to foster sustainable development (Gunn, 2010; Otto & Becker, 2019). Through sustainability education programs, e.g., for employees, it would thus be possible not only to raise awareness and train colleagues in the sustainability of the company, but also to involve teams in the implementation of the transition towards production and consumption mindsets (Otto & Becker, 2019).

The structure of the ESD module is shown in the following graph:

**Figure 1:** Structure of the ESD Module, CC BY-SA-NC Grundmeier

Each thematic area consists of 13 different lectures and a summary. The individual topics can be found in the table.

**Table 1**: Topics of the ESD Module

| | **Part 1**<br>2 ECTS | **Part 2**<br>2 ECTS | **Part 3**<br>2 ECTS |
|---|---|---|---|
| | **Didactic and Methodological Implementation of Education for Sustainable Development (ESD)** | **Sustainable Textile Technologies and Fashion in the European Market** | **Sustainability and Entrepreneurship in the European Market** |
| | | | |
| Teaching unit | | | |
| 1. | From Sustainability Triple-Bottom Line to Advanced Aspects in the Context of Textiles and Fashion | Sustainable Raw and Materials and Textile Materials | Fashion Consumption in the European Market |
| Responsible Author | Dirk Höfer | Anne-Marie Grundmeier | Marcus Adam |
| 2. | Education for Sustainable Development (ESD) as a Guiding Principle in the Context of Fashion and Textiles | Sustainable Knitting Production | Consumer Research |
| Responsible Author | Anne-Marie Grundmeier | Mirela Blaga & Marlen Wagner | Marcus Adam |
| 3. | Research-Based Learning in the Context of Textile Education | Dyeing and Printing in the Context of Sustainability | The Impacts of E-Commerce and Media on Sustainable Fashion |
| Responsible Author | Anne-Marie Grundmeier | Andrei Bertea | Marcus Adam & Jochen Strähle |
| 4. | Design Thinking – a Suitable Method for Implementing Education for Sustainable Development (ESD) in Textile Education | Finishing in the Context of Sustainability | Global Textiles and Clothing Supply Chain |
| Responsible Author | Anne-Marie Grundmeier | Andrei Bertea | Marcus Adam & Jochen Strähle |

| | | | |
|---|---|---|---|
| 5. | Sustainability-Oriented Consumer Education in Fashion and Textiles | Fashion Design in the Context of Sustainable Development of the Fashion and Textile Industry (Part 1) | State of the Art in Globalisation and Industrialisation in the Textile and Clothing Industry |
| Responsible Author | Anne-Marie Grundmeier | Antonela Curteza | Marcus Adam & Jochen Strähle |
| 6. | Empathy, Mindfulness and Ethical Values in Fashion Consumption | Fashion Design in the Context of Sustainability (Part 2) | International Procurement of Textiles and Clothing for the European Retail Market |
| Responsible Author | Anne-Marie Grundmeier | Zlatina Kazlacheva | Marcus Adam & Jochen Strähle |
| 7. | Overcoming the Growth Dilemma – Rational Collective Economy | Pattern Making in the Context of Sustainability: Good Practices | Supplier Relationships |
| Responsible Author | Lisa Fritsch | Zlatina Kazlacheva | Marcus Adam |
| 8. | Lifecycle Assessment | Best Practices of Sustainable Product Development through 3D-Design and Visualization | Social Risk Management in Fashion Supply Chains |
| Responsible Author | Marcus Adam | Manuela Avadanei | Marcus Adam & Deniz Köksal |
| 9. | Sustainable Accountability in the EU Textile Market | Clothing Technology and Production Methods in the Context of Sustainability | Best Practices of Sustainable Business Models |
| Responsible Author | Malte Wessels | Diana Balabanova | Marcus Adam & Jochen Strähle |
| 10. | Societal Health Impact of Textile and Clothing Consumption | Social Health and Environmental Impact in Textile and Apparel Manufacturing Processes | Transparency in Fashion Business |
| Responsible Author | Dirk Höfer | Dirk Höfer | Marcus Adam, Jochen Strähle & Malte Wessels |
| 11. | Microplastic Fibres and Particles in the Textile Chain – Environmental Impact and Health Effects | Selected Projects of Students at Partner Universities (Part 1) | Green Fashion Retail Strategies |
| Responsible Author | Dirk Höfer | Antonela Curteza | Marcus Adam & Jochen Strähle |
| 12. | Vestimentary Communication: | Selected Student Projects at Partner Universities (Part 2) | New Strategies for Sustainable Textiles and |

| | | | |
|---|---|---|---|
| | Clothing as a Medium of Communication | | Fashion in the European Market |
| Responsible Author | Anne-Marie Grundmeier | Zlatina Kazlacheva | Marcus Adam |
| 13. | Cultural and Intercultural Learning in the Context of Fashion and Textiles | Chances and Risks of Sustainable Textile and Clothing Production in the European Market | Chances and Risks of Slow Fashion Strategies and a Circular Economy in the European Market |
| Responsible Author | Anne-Marie Grundmeier | Manuela Avadanai & Mirela Blaga | Marcus Adam & Jochen Strähle |
| 14. | Summary, Reflection and Outlook – Part 1 | Summary, Reflection and Outlook – Part 2 | Summary, Reflection and Outlook – Part 3 |
| Responsible Author | Anne-Marie Grundmeier & Dirk Höfer | Mirela Blaga & Zlatina Kazlacheva | Marcus Adam & Jochen Strähle |

# 3 Didactic and Methodological Implementation of Education for Sustainable Development (ESD)

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

DIRK HÖFER

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 impacts on the environment due to its natural resource consumption, the generation of greenhouse gases and environmental pollution. Additionally, human rights issues within the production of clothing and textiles generate serious social and economic sustainability problems. Fortunately, current industry activity responding to the sustainability challenges suggests a growing commitment to sustainable practices. So, while the environmental, social and economic consequences associated with the clothing and textiles supply chain are serious, there are promising signs that a significant paradigm shift towards sustainability is gaining momentum. In order to reach this conversion, the sustainable clothing and textile industry needs to focus on the triple bottom line (TBL) concept, which describes a sustainable development that takes all stakeholders into account. The concept was defined by the Brundtland Commission of the UN in 1987 and comprises an accounting framework with three dimensions: social, environmental and financial. The TBL concept in the clothing and textiles supply chain turned out to be a universal method for building economic, social and environmental resources while fostering sustainable livelihoods by balancing these three factors.

This lecture aims to assess the extent to which the TBL concept is implemented in the clothing and textile industry of today. Since the apparel life cycle is complicated – from fibre and fabric production as well as garment manufacturing and finishing, to usage and disposal of the apparel products after use – the lecture starts with a detailed profiling of the clothing and textile industry, including its levels of sustainability, its highly stretched, complex and fragmented supply chain, the top retailers, up to the relationship of brands with their customers. The latter includes a deeper insight into today's consumer characteristics and the role of fashion designers. Considering all these influencing factors, it becomes clear that the transformation of the industry towards sustainability needs nothing less than a multi-faceted approach: From the production of eco-friendly raw materials to the disposal of clothing and textile goods, responding to sustainability challenges throughout the supply chain requires a global collaboration of all parties including producers and consumers.

As about 80 percent of the environmental impact and costs are the outcome of the decisions made in the design phase, increasing the sustainability of garments lies in the designers' hands. Moreover, designers decide how emotionally attached consumers will be to apparel, what material to use and how long the product lasts in terms of its appeal. Hence, designers need the knowledge to choose between sustainable materials. By means of life cycle assessments, one has found that extending the active life of garments via the design, maintenance and re-use of clothing is the most effective method to reduce the impact of the clothing industry on the environment. Furthermore, it is the consumer who is highly influential in advancing sustainability within the industry. Efforts should therefore be made to increase consumer demand for sustainable apparel products. Although a growing number of companies have added marketing claims focused on their environmentally responsible practices within product advertisements, sustainable practices related to apparel products are still perplexing to identify for general consumers due to the many life cycle aspects of textiles and clothing that need to be considered.

The future of the textile and clothing industry will likely see a transformation to sustainable apparel retail models such as circular fashion, cradle2cradle or closed-loop business models. This conversion will not only include mandatory supply chain transparency and more creativity of fashion designers and sustainable fashion brands, but also educated, reflected and collaborative consumers with a slow fashion mindset.

## 3.2 Education for Sustainable Development (ESD) as a Guiding Principle in the Context of Fashion and Textiles

ANNE-MARIE GRUNDMEIER

In the *UNESCO Roadmap for the Implementation of the World Programme of Action 'Education for Sustainable Development'* ESD is defined as follows: ESD empowers learners to make informed choices and act responsibly to protect the environment, sustain economies and ensure a just society for current and future generations, while respecting cultural diversity. This definition comprises the complexity and multidimensionality of sustainability. The central guiding theme of sustainable development – intergenerational and intragenerational justice – is taken up and the original idea of sustainability – the conservation of natural resources – is clarified in the definition of the term "sustainability" as well. Since ESD is a lifelong learning process, it also is an essential part of high-quality education. As a holistic and transformative education, ESD considers learning content and outcomes, pedagogy and the learning environment. The goal is a change in society towards more sustainability. Hence, ESD denotes a holistic concept, which is geared towards lifelong learning. Learners should be informed about aspects of sustainability and motivated to work towards sustainable development.

With the future vision of shaping a sustainable and peaceful society, the United Nations adopted the global sustainability agenda known as Agenda 2030 in 2015. A total of 17 sustainability goals specify the areas in which sustainable development must be anchored and strengthened by 2030. Education is indispensable for achieving these 17 goals. High-quality education goes beyond mere factual knowledge and should enable all participants to develop skills such as autonomous action, participation in social decision-making processes, forward thinking as well as interdisciplinary knowledge. As stated in the UNESCO's definition, ESD aims to empower learners in order to make people capable or to give them the necessary skills. Ultimately, it is about the acquisition of competences, such as informed decision-making, responsible behaviour and respect for cultural diversity. But what does this require? On the one hand, learners need to acquire appropriate knowledge as only when people have the necessary information they can make informed decisions, behave responsibly and understand the importance of cultural diversity. On the other hand, they must be able to act based on this knowledge, acquire competences and apply them. What knowledge this includes is indicated by relating responsible action to the three pillars of sustainable development: environmental protection, sustainable economy and a just society.

The distinction between the two levels of ESD – knowledge and skills – is also made by the National Action Plan on ESD, which aims at imparting basic knowledge, tackling key societal problems and acquiring so-called design competence with its sub-competences. The focus on competences is in line with the shift from an input to an output orientation that has taken place in education in recent years. The question of what has to be understood particularly by competences in ESD arises. There are various competence models for ESD, including the concept of design competence by Gerhard de Haan (2008). His twelve popular sub-competences of design competence are phrased in more general terms. They focus on generic competences and are of fundamental importance for education. In comparison, the eleven core competences of the Framework for Global Development Education can directly be connected to competence-oriented subject teaching and are intended to enable students to shape their lives in a way that fits the future, to participate in society and to assume global co-responsibility. In addition to acquiring the ability to create and act, the ESD-related competences are about becoming aware of one's own responsibility and the effects of one's actions.

Many years of experience and empirical research show that sustainability topics should be included in education starting at an early age, as attitudes are formed and solidified in the course of time. Only if ESD is offered as a guiding principle in lifelong learning and progressive curricula, systematically building a step-by-step understanding of the underlying concept with the subsequent addition of more advanced information and competences, key problems are recognised by learners, critically reflected and evaluated. Consequently, sustainable action can be taken.

## 3.3 Research-Based Learning in the Context of Textile Education

ANNE-MARIE GRUNDMEIER

*Research-Based Learning* is a key element of the didactic concept of study programmes. This didactic concept supports the development of the students' critical research and science-oriented basic attitude. Therefore, it fosters the development of professional strategies for professional practice. This is shown, for example, in a reflexive-analytical attitude towards the teaching-learning process, which is designed in accordance with the current state of science.

Accordingly, the courses' contents, didactics and methodologies are oriented towards the current state of research and provide both an overview as well as insights into current research in the respective scientific discipline. Additionally, competencies for the reception as well as the evaluation of results from compilatory and empirical research are developed and deepened. The acquisition of competences in the field of research methods aims to the reception of research and to conducting own research. Competencies for the reception and evaluation of the results of compilatory and empirical research are specifically developed and deepened. In this way, the critical handling of current research literature, the analysis of empirical data as well as the guided conception and execution of empirical research tasks are practiced in relation to the professional field. Different methodological approaches are tested and evaluated. These are then applied in the reception of compilatory and empirical research as a starting point by finding application in own small research projects. Thereby, students are being introduced to research projects that they then undertake independently as part of their master's thesis.

The lecturers' own projects and research focus as well as research projects in cooperation with external partners can be incorporated into the course of study. Among other things, it could be incorporated as a teaching cooperation with institutes and companies that conduct research along the textile value chain. This not only enables students to transfer knowledge of current research into the teaching session but might also integrate them into current research projects. For example, as part of a course, when carrying out their own small research project, but also when master's theses are written in the lecturer's research areas possibly directly connected to a current project. The approach of *Research-Based Learning* additionally offers the possibility to take up the students' heterogeneity and to professionalise them regarding their later occupation. In this way, students' self-efficacy beliefs are taken into account.

*Research-Based Learning* puts the scientific examination of "real-life" problems from professional fields into the focus of university teaching. The *Service Learning approach*, on the other hand, focuses on the students' social engagement and a critical-reflexive

dealing with practical problems. These concepts are variants of *Problem-Based Learning*; accordingly, both are based on the principles of the *Problem-Based Learning* approach. This approach is characterised by the processing of complex problems taken from the research discipline and professional practice, which form the starting and reference point of teaching and learning. They function as both a cognitive and a motivational stimulus for the learning process and as a connecting element between scientific theory and the students' future professional activities. The aim is for students to develop and practically implement concrete suggestions for solving problems by applying their acquired knowledge, skills and abilities. For example, practical problems that form the starting and reference point of the teaching and study process are presented. These might be problems that are selected by the lecturers together with partners from companies and research institutions, or problem areas that are identified as such by students and their lecturers.

## 3.4 Design Thinking – a Suitable Method for Implementing Education for Sustainable Development (ESD) in Textile Education

ANNE-MARIE GRUNDMEIER

Design Thinking is a systematic approach to complex problems from all areas of life – including Education for Sustainable Development (ESD). This is based on the work of IDEO and HPI School of Design Thinking, which further developed IDEO's method of Design Thinking at the Hasso Plattner Institute (HPI) of the University of Potsdam in Germany. IDEO is a US design agency, which pushed for innovation at the beginning of the millennium, especially in technology-related areas by means of Design Thinking. The approach goes far beyond the classic design disciplines such as shape, layout and industrial design. In contrast to many approaches in science and engineering, Design Thinking addresses a task through technical feasibility and economic viability. User requirements and needs as well as user-oriented inventions are at the centre of the process. Designers look at challenges through the user's glasses and thus put themselves into the user's role. Design Thinking involves an iterative process with six phases: understand, observe, point of view, ideate, prototype, and test.

In Germany the promotion of design competence is part of the overarching educational goal of the Orientation Framework for Global Development Learning, which was commissioned by the Federal Ministry for Economic Cooperation and Development and the Conference of Ministers of Education. According to the educational scientist Gerhard de Haan, design competence is the core competence of ESD (2008). It refers to the ability to apply knowledge about sustainable development and to recognise problems of non-sustainable development. This means being able to draw conclusions about ecological,

economic and social developments in their interdependence from analyses of the present and studies of the future. Furthermore, it includes being able to make, understand and individually, collectively and politically implement decisions based on conclusions with which sustainable processes and products can be realised. De Haan's target dimension of sustainability is in accordance with IDEO's definition of innovation. Accordingly, this method brings together what is desirable from a human point of view with what is technologically feasible and economically viable in order to create user-centred innovation, as thinking like a designer can transform the way people and organisations develop products, services, processes and strategies.

In order to implement Design Thinking in textile and fashion companies as well as in textile education, with the aim to foster ESD as a guiding principle, it is important to internalise its 12 underlying principles as a mindset. Creative confidence is a key factor in order to realise design competence. When teachers have confidence in their own creative competence, they are able to foster creativity and design skills in their students. In this context, it is promising to see that de Haan describes 12 sub-competences of design competence which he considers necessary for implementing ESD. They have a high similarity to the principles of Design Thinking. Accordingly, the design process can be understood as a problem-solving method that is potentially transferable and applicable to all living conditions. Areas such as education, economy, politics and challenges of social coexistence also move into the field of consideration. This view thus also implies solutions for a sustainable development. In summary, it can be stated that ESD offers and at the same time demands design competence.

Furthermore, Design Thinking can also be a useful method for the following didactic concepts: *Research-Based Learning*, which puts the scientific examination of "real-life" problems from professional fields into the focus of university teaching, and the *Service Learning* approach, which focuses on the students' social engagement and a critical-reflexive dealing with practical problems. These concepts are variants of *Problem-Based Learning*; accordingly, both are based on the principles of the *Problem-Based Learning* approach. This approach is characterised by the processing of complex problems taken from the research discipline and professional practice, which form the starting and reference point of teaching and learning.

## 3.5 Sustainability-Oriented Consumer Education in Fashion and Textiles

ANNE-MARIE GRUNDMEIER

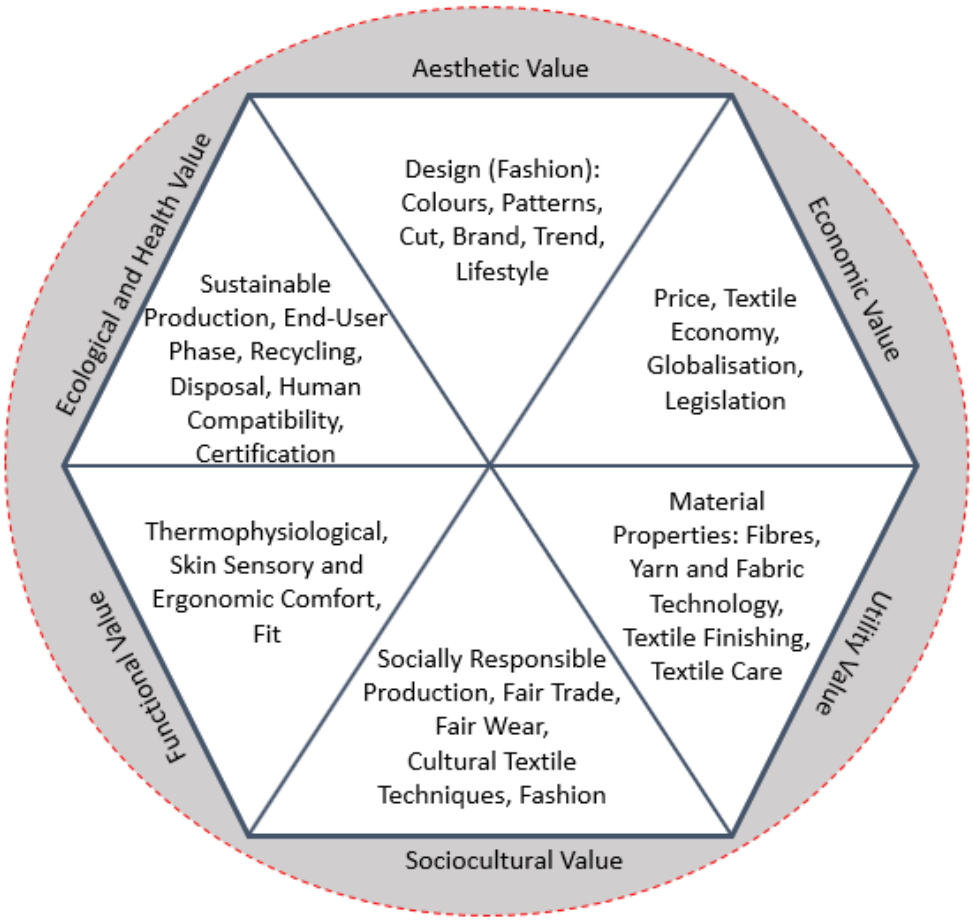
Consumption is considered a key driver of environmental change as consumer goods cause global pressure through their production, use and disposal. The overarching goal of Education for Sustainable Development (ESD) is to enable people to participate in shaping and contributing to a sustainable development. In order to realise this participation, it is necessary to make reflected decisions according to the requirements arising from a sustainable development. Against the background of widespread concepts, decisions in the context of sustainable development are characterised by several criteria. On the one hand, there are ecological, economic and social criteria, on the other hand, global and local contexts and the temporal perspective play an important role. These aspects influence each other and can also contradict each other. Accordingly, such decisions have a high degree of complexity and require individuals to weigh up, make informed choices and reflect on their decision-making processes in the context of sustainable development. In the sense of this normative orientation of ESD, the promotion of decision-making competence within the framework of formal education pursues the goal of enabling learners to reflect on decision-making processes. This excludes purely intuitive decisions, which are of secondary importance with regard to the ability to shape sustainable development or to promote responsible participation.

The focus is on the investigation of the course of reflective decision-making processes. In the consumption segment of fashion and textiles, the reflected participation of the individual is of considerable importance, since local actions of consumers influence the globally organised textile and fashion industry. The younger generation in particular is aware of social and ecological grievances in the textile value chain and criticises them, however, sustainability criteria play a subordinate role when buying clothing as different studies show. This consumer behaviour is referred to as the *attitude-behaviour gap*.

In contrast to ethical dilemma situations in natural science topics, several options for action can be developed for evaluation situations in the context of consumer education, which can be considered as a solution under the guiding principle of ESD. The Göttingen model for bioethical decision-making processes by Eggert and Bögeholz (2006) provides an orientation framework for the diagnosis and cognitive promotion of “assessment competence”. Before the actual evaluation can be carried out, facts must first be clarified and the possible problem must be grasped. To do this, learners need to adopt a variety of perspectives and relate them to values when systematically evaluating possible courses of action. Previous research has shown that students have difficulties in dealing with a systematic approach to decision-making and have almost no meta-strategy or

evaluation structure knowledge. A systematic approach to decision-making situations is not possible without such knowledge. Furthermore, without a systematic approach, they tend to decide intuitively or justifiably. However, from a didactic and educational policy point of view, the demand for “assessment competence” is to be able to make systematic and justified decisions in complex situations. Moreover, the measurement of evaluation skills needs to map the use of certain strategies as well as the decision-making process in connection with the decision and not only to assess the final result.

**Figure 2:** Quality Circle for Clothing and Accessories, CC BY-SA-NC-ND Grundmeier




In this lecture, the three dimensions of sustainable development, ecology, economy and social issues, are extended by the dimensions of aesthetics, utility value and functionality for fashion and textiles and presented in a quality circle. In order to be able to competently make qualitative assessments and decisions, different quality dimensions must be considered in a differentiated manner. With the help of the quality circle, learners should ask questions about the consumer segment of fashion and textiles, they should analyse and judge from several perspectives with the aim of being able to select fashion and textiles in a more reflective and quality-conscious way.

## 3.6 Empathy, Mindfulness and Ethical Values in Fashion Consumption

ANNE-MARIE GRUNDMEIER

The increase in fashion consumption can be attributed to the rising prevalence of fast fashion, releasing an increasing number of collections each year with highly competitive pricing and ever-shorter usage periods. With the extreme acceleration of the fashion market, the quantity of old clothes and the variety of materials are constantly on the rise. As a result of the quantities of clothing, which on average have also lost material and processing quality, appropriate reuse via second-hand, swapping and borrowing or upcycling are becoming less and less possible. Instead, textiles and clothes have to be incinerated more and more frequently in order to at least use the heating energy. One strategy to escape this development on the consumer side is to avoid fashionable new acquisitions – a kind of fashion diet. Avoiding new purchases is mainly about consciously selecting needed clothing and avoiding impulse or reward purchases. Second-hand clothing, for example, can be purchased instead. Participation in clothing swap is also an option, both to get “new” and to pass on one’s own clothes. In addition, clothes can be borrowed for a certain period of time and then returned.

Following the purchase, proper textile care significantly contributes to the extension of the clothing’s life cycle. Furthermore, developing textile skills such as repairing clothing (sewing on a button, replacing zippers, closing open seams, repairing minor holes) is another relevant point, as minor damage can be repaired at home or at a tailor's if necessary. However, if the garment is further unusable, there is the option of upcycling, in which the initial product is typically upgraded. However, the possibilities of deceleration in the consumption phase are countered by planned obsolescence, especially in fast fashion: These clothes are manufactured in such a way that after a short period of use they lose their colour and shape, show material damage and are probably beyond repair to cause new clothing to be purchased. The constantly changing trends lead to a psychological obsolescence even of clothes that are still wearable because they are out of fashion.

The question is how to deal with these developments in terms of a systemic change since slow fashion is much more than simply slowing down. Slow fashion is not a trend, but a movement that focuses on the longevity of clothing. The ideal of higher quality garments produced in smaller quantities under fair and sustainable conditions is the cornerstone of this philosophy. As long as we continue to buy enormous amounts of fashion – albeit sustainable and fair – the problem cannot be fundamentally solved. For a systemic change, it is not enough to design production methods and products sustainably. It is the mindset of consumers that has to be changed. They need to

fundamentally rethink their relationship with the garments they purchase, own and wear in terms of sustainable use. If consumers redefine the way they interact with clothing as a whole – the acquisition, use, alteration and care of garments – there is a chance that perspectives and action competencies will change. They are then no longer just passive consumers of the trends and styles dictated by brands and designers – their interaction with clothing will be transformed into an active and personal experience. Individual clothing items will be valued the longer one owns and wears them. The focus is on selecting, keeping, wearing and caring of clothes.

This lecture also raises the question of the teacher's role, who should show their students the way of decision-making and try to awaken their empathy without becoming moralizing or prescribing a certain way of dealing with clothes. Rather, the goal is to encourage people to rethink their role as consumers: what are we already doing, what could and should we be doing to increase the lifespan of clothing if we put the preservation of our planet first in terms of an inter- and intragenerational justice? According to Kate Fletcher of the Centre for Sustainable Fashion in London, rethinking fashion consumption is the first step towards true slow fashion.

## 3.7 Overcoming the Growth Dilemma – Rational Collective Economy

LISA FRITSCH

This lecture develops basic principles for an economic model in which the conflict of goals between economic growth and sustainability in a market economy can be overcome. The following questions will be addressed: What does a sustainable economy need to entail for being applicable as well as meeting sustainability goals? Is this not a contradiction in terms? Or: Can sustainable action be possible in an individualistic society? As a possible solution, the construct of the Rational Collective Economy is developed. This economic model is based on a rational view of human beings in accordance with the idea of the homo economicus while keeping the aims of sustainability in mind. To develop this construct, basic knowledge about economics, business administration and sustainability is needed. Therefore, this knowledge is elaborated in the first chapter. If prior knowledge already exists, the first chapter can be skipped.

The second chapter examines sustainable economic models and classifies them in terms of business administration based on economic theory and business administration based on behavioural sciences. (If there is not enough time to work through the entire course material, Chapter 2 can be skipped.) The classification reveals that sustainable economic models are generally based on an emotional view of human beings and are rarely applied in reality. This insight is the basis for the sustainable economic model

developed in this lecture, which can endure in a market-based society. Sustainability can only be achieved if we recognize that individual benefit cannot be achieved without ensuring (environmental) sustainability first. Therefore, sustainability is not an additional benefit but a means to an end and must be included in every economic decision. To make the concept of sustainability and the deeper problem more tangible, chapter 3 explains the growth dilemma. Here, a hierarchical structure is revealed within the dilemma, in which environmental protection is the basic condition for sustainability. Rationally acting individuals can therefore only achieve their goals if the basic condition of environmental protection is guaranteed. With the help of this basic assumption, the concept of a Rational Collective Economy can be derived. Chapter 4 shows that individual and collective interests coincide when we assume that individuals always want to maximize their own benefit and that profit maximization only is possible if the condition of protecting the environment as a collective good is met. Thus, this model is a collective economy in which, in contrast to economic models classically oriented to the collective, action is not emotional but rational. In short, it is a Rational Collective Economy. It is based on the following guiding principle:

*Individuals, in pursuit of their own benefit, do not consciously promote the common good. However, since they are compelled by external circumstances to pursue environmental protection, they promote the common good in this sense. They contribute to increasing the common good in the pursuit of their own interests.*

Chapter 4.2 explains the basic assumptions of a rational collective economy. These consist of the integration of sustainability into a market economy, a new conceptualization of sustainability and an adaptation of the homo economicus. Chapter 4.3 describes challenges in a rational collective economy and how they could be dealt with. Finally, a possible experimental setup for testing the theory is presented.

Each chapter is organized as follows: First, the theoretical basis is explained, followed by tasks to understand and advance the theory. These tasks are also suitable as topics for essays. This is followed by a recap of the chapter, in which all relevant contents are summarized. All contents of the recap should be covered to meet the learning objectives. With appropriate preparation by the presenter, only the recap slides can be used. The recap slides are focused on graphically showing the content rather than explaining it. For presenting only the recap slides, the presenting person must explain all the information provided in the Basic Knowledge part of the chapter. Each chapter concludes with its underlying sources.

This lecture develops the theoretical basis for a sustainable economic model. Students will be nudged to venture in new directions in economic theory to deal with current problems. The considerations of a rational collective economy show that it is not only

possible but also necessary to rethink and reinterpret theoretical principles in order to be able to face the climate crisis.

## 3.8 Lifecycle Assessment

MARCUS ADAM

The global textile supply chain is complex, involving many different stages and people. It is extremely resource-intensive and causes significant environmental issues. High input of water, energy and harmful chemicals is used along the entire value chain. As early as in the 1970s researchers and decision-makers were interested in the resource use and environmental damage implications of particular products and packaging options. This has been the starting point for the development of the Life Cycle Assessment (LCA) methodology. For LCA analyses, environmental data and process inputs and outputs have to be collected. This comprises data on the use of toxic chemicals, the consumption of water and energy, the generation of waste, air emissions, transportation, and packing materials.

LCA must be separated from carbon footprinting. Carbon footprinting is the central method for assessing the impact of textiles on climate change, however, only one impact category (climate change) is considered. LCA considers other resource, environmental and human health categories, like energy consumption, impacts on habitat and the emission of carcinogens. LCA is a technique to assess environmental impacts associated with all the stages in the life cycle of a product, from raw material extraction, through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. It is comprehensive and involves a systematic scientific approach to examine the environmental impacts of the entire life cycle, which is not simply about the quality of the product, nor the amount of waste ending up in a landfill or an incinerator. Moreover, the life cycle of a product determines its environmental impact. This is also a way of measuring whether green improvements have been made or not.

LCA results answer the question “How much does a product system potentially impact the environment?” The quantitative nature of LCA means that it can be used to compare the environmental impacts of different processes and product systems. This can, for example, be used to judge which products or systems are better for the environment or to point to the processes that contribute the most to the overall impact and therefore should receive attention. LCA is recognized in the ISO 14040, which describes LCA as a four-step process that involves goal and scope definition, inventory analysis, impact assessment, and interpretation.

LCA has specific limitations. First of all, an LCA study is resource consuming, mainly due to the large amount of data needed. If data collection is poor, or if not enough data are available, the study will not lead to solid conclusions. Furthermore, LCA studies depend on assumptions and scenarios, as LCA assesses the real world in a simplified model. Finally, it is not easy to communicate the results of an LCA study.

## 3.9 Sustainable Accountability in the EU Textile Market

MALTE WESSELS

Accountability can be referred to as “acknowledging responsibility for my actions”. This implicitly requires transparency, observation, and evaluation of corporate actions. The EU legislation supports the demand for accountability of legal entities by regulation. The International Financial Reporting Standards (IFRS) is issued by the International Accounting Standards Board (IASB), the standard-setting body of the IFRS Foundation and required by approximately 170 jurisdictions worldwide. Its objective is to provide users of financial statements information that is useful for decision-making. Companies should present a true and fair view of their financial position, performance and cash flows. Future reporting will need to include non-financial information more comprehensively to reflect these developments. The current requirements can be viewed critically and there is a necessity for sustainability reporting requirements.

Until now, companies have been able to use different frameworks for their reporting, such as the German Sustainability Code or the standards of the Global Reporting Initiative (GRI). To improve the comparability and quality of sustainability reporting, companies are now required to use uniform reporting standards which, among other things, specify the information to be reported and the type of reporting (e.g., structure of the report). It should be noted that the standards should also cover corporate governance aspects. The standards will be issued by the EU Commission by way of delegated acts; for SMEs, standards are envisaged which take into account the special features of these companies. A staggered timetable is envisaged for the adoption of the standards. The EU Commission is required to consider the technical advice of the European Financial Reporting Advisory Group (EFRAG) when developing the standards.

The Commission has recently revised its CSR Directive and extended the scope. The group of companies that will have to report on non-financial aspects in the future is consequently growing strongly. In principle, all companies listed on a regulated market in the EU (except for micro-entities), as well as large non-capital-market-oriented companies and most banks and insurance companies, will be required to report on non-financial indicators in the future, thus contributing to greater transparency on sustainable aspects.

It is not only the EU Commission that has taken up the issue of sustainability reporting: The IFRS Foundation – responsible for the internationally recognized accounting standards IFRS – has founded a new entity, the International Sustainability Standards Board (ISSB), which is to develop global basic standards (Global Baseline) in the area of sustainability reporting in the future. The ISSB was already joined by several voluntary initiatives when it was founded. With the founding of the ISSB, two prototypes were published on the topics: Climate reporting and general requirements for the disclosure of sustainability-related financial information.

## 3.10 Societal Health Impact of Textile and Clothing Consumption

DIRK HÖFER

Various chemicals, which modify or improve vital qualities and the performance of textiles, are used to produce textile products and garments. As a result, these chemicals are intentionally or unintentionally present in finished consumer products. Even though there are many benefits of the use and presence of these chemicals in textiles for wearers, they may have detrimental effects on consumer health and the environment upon exposure. Different modes of legislation which regulate the use of specific chemicals in the textile manufacturing process and different stages of the life cycle of a textile product have been established. For instance, REACH and CLP are the two fundamental community acts established for governing the use of chemical substances in the EU. In addition, companies have become aware of the need for eco-labels and eco-friendly products. Despite these initiatives, information about the exposure of consumers and potential human health risks during consumption are still limited. The lecture therefore focuses on the topic of human ecology – the interrelation of consumers with their inanimate fabric environment – and gives a brief overview of understanding the chemical health risks of textile and clothing consumption.

In principle, chemicals used in the textile value chain can be categorised into functional/effect chemical substances, auxiliary chemicals and substances not intentionally added, such as contaminants or degradations. The human health risks caused by the exposure of clothes are mainly due to a variety of inorganic and organic harmful chemicals from textiles like brominated flame retardants, carcinogenic formaldehyde, allergenic and carcinogenic aromatic amines/azo dyes from skin contact clothes, endocrine disruptors phthalates, benzothiazole/ benzotriazole and the human carcinogens, quinolones and bisphenols. In addition, a variety of metals which are known to have multiple effects on organs can be found in branded textiles. The ingredient chemicals in textiles are released by various mechanisms such as migration, leaching,

evaporation and particulate releases and may finally end up in human organs or ecosystems.

Risks and negative side effects related to textile chemicals occur due to human exposure. Although dermal exposure to textile chemicals predominates, as it exists almost 24 hours per day and the skin is the largest organ of the human body, there are also other modes of exposure such as inhalation, oral and environmental exposure. After the exposure to textile chemicals, the impact of textile chemicals on humans is diverse, encompassing complex toxicity pathways such as interferences with the immune system or fetal/child development, endocrine disruption, carcinogenicity or contact dermatitis. The subject areas of human toxicity and chemical risk assessment of textile chemicals will be addressed in this lecture in detail.

Presently, control over different health and environmental hazards on account of the exposure to chemicals is very difficult to achieve by the textile and fashion industry due to the chemical diversity used. Moreover, information about the chemicals is not always transparent and does not always move smoothly along the complex and multitiered textile supply chain. However, the increasing research findings and public awareness about health risks of textile and clothing consumption induces textile manufacturers to change their processes as well as use eco- and health-compatible chemicals in order to offer more sustainable products.

However, there is the necessity of developing robust policies to force the elimination of harmful chemicals from manufacturing processes of textiles, and consequently, in the finished products as consumers have little knowledge of the impact of textile chemicals on human health. Hence, the goal of Education for Sustainable Development is for consumers to become educated, conscious and collaborative. The impact of textile chemicals and their exposure to the body cannot be overlooked but can largely be reduced by changes in the shopping behaviour of consumers and in the use and care phase of clothing. At the point of sale, labelling is the primary tool for marketing textiles and clothing to well-informed and ‘green’ customers. Some eco-labels stimulate consumers to buy health-compatible fabrics. Moreover, the underlying certification process, in turn, stimulates producers to produce with substances that are harmless to health. Until the rise of a federally regulated transparency in the supply chain, voluntary labels allow consumers to make first comparisons among products regarding healthy and environmentally preferable products.

## 3.11 Microplastic Fibres and Particles in the Textile Chain – Environmental Impact and Health Effects

DIRK HÖFER

Nowadays, approximately two-thirds of all textile items are synthetic, dominated by petroleum-based organic polymers, such as polyester, polyamide and acrylic. However, besides manifold advantages, synthetic and cellulosic textiles release fibres into the environment during their production, use and at the end-of-life disposal. Predominately, by the weathering and breakdown of synthetic textiles and clothing, also other plastic objects, plastic particles and fibres smaller than 5 mm are created. This results in an anthropogenic debris named as microplastics. Today, the presence of microplastics is confirmed in freshwater ecosystems, marine habitats, air as well as in soil in all regions of the globe including rivers, seas and coastal shorelines. In all ecosystems, microplastic fibres and particles persist for decades, for example when soils are treated with sludge from wastewater treatment plants. A future sustainable textile value chain thus has to cope with this issue.

The ubiquity of microplastics constitutes a serious risk to the environment and a potential risk to human health, a source of exponential pollution that is currently and undeniably out of control and in contradiction to sustainable development goals e.g., 14 and 13 “Life on land” and “Life below water”. The environmental and health costs involved in textile manufacturing and consumption of synthetic fibres are widespread. Increased consumption patterns have created millions of tons of textile waste in landfills and unregulated settings. When cut during the production or laundered, many synthetic fibres shed microfibres and microparticles. These account for up to 35% of microplastic pollution in the world’s oceans thus emphasizing that the production and consumption of fast fashion is a main driver behind the microplastic issue.

Concerning the implications for human health, there is a growing body of evidence suggesting widespread exposure of humans to microplastics via food, drinking water and air. Presently the inevitable human external exposure is most probably underestimated as the fraction of smaller-sized particles (10 µm) is not included, particles which are likely more relevant to toxicity. Once in contact with the epithelial linings in the lung or intestine, microplastics may cause physical, chemical and microbiological toxicity. In all biological systems microplastic exposure may cause particle toxicity with oxidative stress, inflammatory lesions and increased uptake or translocation into cells. The inability of the immune system to remove synthetic particles may lead to chronic inflammation and an increased risk of abnormal growth of cells (neoplasia). Furthermore, microplastics may not only release harmful additives like unreacted monomers or unbound chemicals but also contaminants and pathogenic organisms absorbed from the environment.

Nonetheless, knowledge of microplastic toxicity is still limited and largely influenced by exposure concentration, particle properties, adsorbed contaminants, tissues involved and individual susceptibility, requiring further research.

Even in indoor air microfibres have been found, shed by abrasion of fibres and particles from carpets and furnishing. Epidemiological studies on occupational diseases in the clothing and textile industry revealed that the hazard due to inhaled microplastics and fibres is even more distinct: Studies reported on lung injuries including byssinosis – a non-specific chronic respiratory disease of textile workers exposed to dust of cellulosic microfibres –, inflammation and fibrosis as well as cancer suspicion and a pronounced risk of miscarriages.

In sum, the environmental and health risks assigned to microplastics likewise affect both consumers and producers of textile and fashion articles. Its entry into biospheres can largely be reduced by sustainable washing behaviour and consumption, especially by reduced consumption of clothes made of synthetic fibres. In recent years, the European Union has launched various governmental regulations to mitigate the microplastic issue, such as the EU Microplastic Positioning Paper, the ban on throwaway plastics and the EU Green Deal. The lack of crucial data on exposure and hazard represents key knowledge gaps that need to be addressed in order to move towards a more sustainable future textile and clothing industry.

## 3.12 Vestimentary Communication: Clothing as a Medium of Communication

ANNE-MARIE GRUNDMEIER

Clothing is primarily a medium of non-verbal communication. Therefore, the concept of vestimentary communication is built on the central assumption of its symbolic nature. As an object, clothing has an effect on the wearer in its materialization and objectivity. In their objectification, clothes are carriers of invisible properties and unfold their symbolic nature. Symbols are carriers of meaning that denote an idea of something. Thus, judgments about the wearers can be made through clothing. One of the consequences of vestimentary communication is that the reception, deciphering and interpretation of clothing typically take place before verbal communication. Usually, this process happens completely uncontrolled. Whether the wearer uses his or her clothing consciously or unconsciously in the sense of impression management, the fashioned body is interpreted and thus vestimentary communication always takes place. In other words, we cannot escape communication because of the clothing we wear. It is an indicator of status, social affiliation, gender, personal taste or (fashion) competence, but also of our temporary

emotional state. It is obvious that, given the relevance and influence of a person's appearance that can be explained in this way, clothing is consciously used to control impressions. It is therefore important to question the true content of clothing messages in order not to make the mistake of an oversimplified analysis.

Like other sign systems, vestimentary communication also has a considerable inherent complexity. Firstly, communication with clothing is always accompanied by a multitude of other, non-vestimentary information that a person conveys and which then influences the decoding of information. The complexity of vestimentary communication is further increased by the possibility of multiple assignments of different meanings to one and the same symbol. Another contribution to the fact that the interpretation of vestimentary codes strongly depends on the recipients is made by the great freedom in dealing with clothing after the renunciation of strict dress and class codes in the feudal system by the strongly spreading bourgeoisie in the nineteenth century. Due to the further democratization of fashion that has taken place since the twentieth century and the accompanying lack of collective understanding of dress codes, the encoding of vestimentary messages has lost its unambiguity. Dress messages are now ambiguous, which means that the situational process of meaning construction and the experiential world of the recipients have become more important. Clothing refers to known codes and clothing codes move in a free space of possible sign relations, which are again subjected to their own structuring and meaning construction in every situation. This treatment of clothing as a code is particularly evident in fluid gender constructions and youth scenes.

According to cultural studies research, there is an almost ambivalent picture of vestimentary encoding, as there is a situational interpretation of clothing by the recipients on the one hand, and on the other hand clothing is received in its symbolic nature in relation to groups and cultures. In this way the encoding can be traced back not only to individual but above all to cultural attribution processes. The decoding of vestimentary messages can neither be detached from the recipients nor from their cultural imprinting and is always multifactorial conditioned. In addition, vestimentary communication is often based on implicit knowledge, which directs our behaviour. As a result, the wearer is not aware of his or her own vestimentary message. However, the unconsciousness of vestimentary communication is not only on the side of the wearer but also on the side of the recipient. Thus, clothing can be understood as a very personal language, which’s individually used signs require a multitude of further not only personal information in order to become comprehensible.

This lecture deals with the historical development of clothing and fashion as a predominantly non-verbal means of communication and fashion theories as well as the scientific discourse on clothing and fashion. A current facet of this is that a sustainable lifestyle can also be expressed through appropriate clothing. An interpretation of clothing

in terms of a self-statement – either sustainable or not – is to be understood in terms of the identity, the social distinction and cultural background of the wearer. The meaning of clothing messages is thus constituted in what shall be stated and what is not. Finally, vestimentary communication cannot be interpreted as the transmission of purely objective facts since its message is received not only cognitively but also emotionally.

## 3.13 Cultural and Intercultural Learning in the Context of Fashion and Textiles

ANNE-MARIE GRUNDMEIER

The term “cultural education” is a container term. This means that there is no one definition of this term. Rather, it encompasses an intersection of the fields of culture and education and refers to scientific and practical fields as well as educational processes. Cultural education always refers to a field of practice, but also to a biographically individual educational process. A variety of formats, types of facilities and institutions contribute with their cultural offerings to a productive networking of theory and practice in order to be conducive to art and cultural education. The engagement with the arts and cultures aims at a specific attitude and is based on potentials and effects that underlie cultural education. The focus is on a creative-aesthetic confrontation of the self with the world.

Although cultural exchange between ethnic groups has existed since time immemorial, today it is omnipresent due to mobility, globalisation and digitalisation. We live in a multicultural immigration society, experience cultural exchange as enrichment and integrate different objects, actions and traditions into our everyday life; at the same time, there is potential for conflict in encounters with foreign cultures. A variety of concepts and structural models for the development of intercultural competence have been presented, but no model has yet been able to establish itself in view of the multidisciplinary approaches. This is also reflected in the coexistence of different terms such as interculturality, multiculturality and transculturality and corresponding competences.

Representatives of intercultural education intend a successful interaction through which interculturally competent people can understand participating cultures in such a way that mutually satisfying and appreciative cooperations can develop. The existing diversity can be used to achieve common goals. This orientation is also criticised as an instrumentalisation of cultural competences aimed at avoiding misunderstandings, disruptions and friction losses. In intercultural education, the focus is on personal development which shifts the concept to the subject level and enables a connection to subject-oriented educational concepts, but also reduces the intercultural concept to one

perspective. In connection with intercultural concepts, the narrowing of the perspective to homogeneous national cultures is also criticised. More recent approaches define culture in terms of groupings without national boundaries. It is assumed that culture can be identified in every type of grouping, e.g., as a corporate company culture, fan culture, food culture and housing culture. A person can be part of different groupings or cultures at the same time, even if there may be differences between the individual members. Despite individual diversity, there is a culture that unites the grouping.

The approach of multiplicity and simultaneity of cultural groupings raises the question of what is supposed to be special about intercultural competence when it is one culture out of many in which a person interacts. There is no definitive answer to this critical discourse yet. Coping with cultural diversity and the challenges it brings requires competences in intercultural and multicultural interactions. So far, the concepts of interculturality and transculturality do not offer an all-encompassing approach. This lecture therefore opens the discourse, refers to various concepts and offers examples within the context of fashion and textiles. Furthermore, a connection between cultural and intercultural education and the implementation of sustainability aspects and ESD is explained.

The textile-cultural dialogue, an important concept developed by the Institute for Aesthetic-Cultural Education at the European University of Flensburg, is understood as a subject-specific focus on cultural dialogues with textile media as material representatives of culture. In this concept, culture is understood as a unifying quality in all kinds of internally differentiated groupings, in which the approach is taken from the subject. Thus, the textile-culturally active person with his or her activities, such as practising textile techniques, with his or her knowledge about and dealing with clothing and fashion is the focus of interest. Accordingly, textile culture is the conscious and unconscious activity visible in textile objects, clothing and fashion and in textile-related ways of acting. Textile cultural activities encompass all textile-related modes of action and focus on the subject. The cultural activity is accompanied by textile-cultural communication as a dialogue between object and subject and between interaction partners.

## 3.14 Summary, Reflection and Outlook – Part 1

ANNE-MARIE GRUNDMEIER AND DIRK HÖFER

Today, university lecturers as well as trainers in companies and teachers at secondary schools are not yet sufficiently sensitised and didactically and methodically trained to teach ESD in the textile and fashion sector and thus act as multipliers for the younger generation, i.e., students and pupils. Therefore, the didactic and methodological concepts

presented within the first part of the ESD module provide useful information, insights and ideas for improvement. It aims at strengthening attitudes and beliefs for ESD and sustainability in general. For that, it addresses a complex and integrating approach in the curricula in all areas and at several levels of education. It starts with vocational schools by offering participatory teaching and learning methods that motivate and empower learners to change their behaviour and take action for sustainable development.

The first lecture starts with a detailed profiling of the clothing and textile industry, including its levels of sustainability, its stretched, complex and fragmented supply chain, the top retailers, up to the relationship of brands with their customers. Within this overview lecture, the audience is also familiarised with the triple bottom line concept, which describes a sustainable development that takes all stakeholders into account. However, the devastating impact of the textile and fashion industry cannot be prevented by an industrial transformation alone unless consumption patterns change at the same time. This requires a habit change in the way that consumers think (knowledge) and act (skills), such as the handling of textiles and clothes. Training vocational and university students to adopt sustainable behaviour is therefore crucial. Hence, ESD education is not only necessary to transmit knowledge, but also to provide future graduates with competency-based training and skills such as autonomous action, participation in social decision-making processes, forward thinking as well as interdisciplinary knowledge. This holistic and transformative view on ESD as a guiding principle in the context of fashion and textiles is also part of the UNESCO Roadmap 2030 for ESD, the National Action Plan on ESD and topic of the second lecture of the module entitled “Education for Sustainable Development (ESD) as a Guiding Principle in the Context of Fashion and Textiles”.

Lecture three of this module addresses the didactic concept of research-based learning, an active teaching and learning strategy, that aims to support the development of the students’ critical-research and science-oriented basic attitude. Based on the current state of science, a reflexive-analytical attitude towards the teaching-learning process might be a target-oriented approach to implement ESD. As simple predictions based on linear causal relationships are very rare to solve sustainability issues, lecture four focuses on Design Thinking, a systematic approach to complex problems from all areas of life – including ESD. On the one hand, Design Thinking can be a useful method to support didactic concepts such as research-based learning and, on the other hand, the approach has the potential to foster ESD as a guiding principle in textile education as well as in textile and fashion companies.

Sustainability-oriented consumer education in fashion and textiles is the subject of the fifth lecture of this module, which acquaints participants with a consumer behaviour known as the attitude-behaviour gap. This term explains why consumers are aware of social and ecological grievances in the textile value chain, although sustainability criteria

play a subordinate role when buying clothing. To overcome the attitude-behaviour gap, consumers need reflective decision-making processes and effective tools, such as the quality circle, to analyse and judge from several perspectives with the aim of being able to select fashion and textiles in a more reflective and quality-conscious way. Lecture six on fashion consumption, mindfulness and ethical values offers certain strategies that can help minimise the gap between consumers' willingness to purchase items and their moral standards with respect to fair-trade clothes. It also raises the question of the teacher's role, who should show his/her students the way of decision-making and try to awaken their empathy without becoming moralising or prescribing a certain way of dealing with clothes. Rather, the goal is to encourage people to rethink fashion consumption as the first step towards true slow fashion. After this, lecture seven deals with overcoming the growth dilemma and explains various sustainable economic models.

Lecture eight looks at the Life Cycle Assessment (LCA) of the textile value chain, a technique developed in the 1970s which, apart from the carbon footprint method, evaluates the environmental impacts associated with all stages in the life cycle of a product, from raw material extraction, through material processing, manufacturing, distribution, use, repair and maintenance, as well as disposal or recycling. Following that, the ninth lecture deals with the topic of sustainable accountability in the EU market. Unfair and unfettered global trade has made it possible to outsource and hide the exploitation of people and nature. This economic strategy means that companies can avoid responsibility and that blame for supply chain abuses can be shifted onto actors outside the EU. Therefore, global accountability and responsibility should be at the heart of the EU's relationship with textiles and clothes in the future.

Lecture ten focuses on the topic of human ecology – the interrelation of consumers with their inanimate fabric environment – by giving a brief overview of understanding the chemical health risks of textile and clothing consumption. The impact of textile chemicals and their exposure to the body are disclosed in this lecture and the effectiveness of regulations and eco-labels are discussed. Another relevant health topic affecting both consumers and producers is microplastic, a topic treated in lecture eleven. Microplastics are plastic particles smaller than 5 mm, which are created by the weathering and breakdown of many plastic objects including textiles. Their ubiquity in the environment raises serious concerns about their effects on wildlife and ecosystems including environmental and health risks. Effective regulations and a sustainable approach to clothing are needed to prevent these risks from increasing further. Lectures ten and eleven are therefore both educational packages that provide knowledge about the health of ecosystems, as a prosperous society depends on a healthy environment. The twelfth lecture deals with vestimentary communication, in which fashion is understood as a medium for communication. The historical development of clothing and fashion as a predominantly non-verbal means of communication and fashion theories as well as the

scientific discourse on clothing and fashion are specifically explained. Lecture thirteen on cultural and intercultural learning for sustainability-oriented textiles and fashion aims to build up competences in intercultural and multicultural interactions and to demonstrate the benefits of cultural and intercultural education for the implementation of sustainability aspects and ESD.

The ESD module's first part mainly aims at lecturers, teachers and trainers in vocational education and their students as further employees in the textile and fashion industry – being consumers at the same time. In the outlook, beliefs, knowledge as well as their impact on teaching, learning and meaning for ESD are discussed.

# 4 Sustainable Textile Technologies and Fashion in the European Market

## 4.1 Sustainable Raw Materials and Textile Materials

ANNE-MARIE GRUNDMEIER

The global fibre market was about 113 million tonnes in 2021 and is expected to increase to about 149 million tonnes by 2030. Natural fibre production goes hand in hand with a high demand for land and water and, in conventional production, also with the use of pesticides and artificial fertilisers. Man-made fibre production, on the other hand, has a high consumption of petroleum and energy. Cotton is still the most important natural fibre. The central environmental burdens of cotton cultivation are water consumption through artificial irrigation and the use of pesticides and artificial fertilisers. Organic cotton cultivation is the most popular form among the cultivation alternatives, but its global production continues to lag all other alternatives in terms of volume, with less than 1.5 percent market share. Genetically modified cotton has become much more important. Its cultivated areas now account for over 79 percent worldwide. Other more sustainable kinds of cottons are focused on better pesticide and water management and/or fair pay for people working in the cotton industry. Sheep's wool accounts for over 1 million tonnes of fibre produced worldwide, making it the most important natural animal fibre. Angora, alpaca, camel, cashmere, llama and mohair wool have a very small share compared to sheep wool. There are some unsustainable practices in conventional animal husbandry, which is why animal welfare standards and certifications have been introduced.

Pulp production for man-made cellulosic fibres should be based on sustainable forestry, and production waste from the cellulose spinning mill and waste from cotton production can also be used. The amount of chemicals used in viscose and modal fibre production is very high. An alternative is the direct solvent process, in which the cellulose is spun into lyocell fibres in the organic solvent amine oxide N-methylmorpholine-N-oxide (NMMO). The manufacturing process, which has the highest solvent reusability of all cellulose fibres, is considered to be significantly more environmentally friendly compared to the processes of other regenerated cellulosic fibres. Man-made fibres from synthetic polymers, which are mainly produced from the petroleum derivative naphtha, cover most of the global fibre production. The problem lies in the finite nature of the resources. Another problematic factor is the energy required and the chemicals used as auxiliaries in the production of synthetic man-made fibres. Synthetic fibres contribute to environmental pollution with microplastics during production, wearing and washing.

When it comes to the search for a solution that contributes to a circular economy and to covering the world's demand for fibres, the recycling of textiles and old clothes comes to mind. Especially so, when thinking about the ever-growing volume of old clothes. On the way to closed material cycles, however, fibre mixtures between fibres based on natural and synthetic polymers in particular make recycling difficult. Additionally, the fibres lose considerable quality during recycling, which is why they must be disposed of again in the end. As long as this problem has not been solved, the principle of grade purity applies to high-quality raw material recycling. So far, the recycling of PET bottles into polyester fibres has become established. The plastic bottles can be processed either chemically via depolymerisation or physically. The recycling of polyester textiles requires the collection of e.g., ocean plastic, washing, decolourising and melting, which entails a high input of energy and chemicals.

Bio-based plastics made from sugar, starch, vegetable oils or even chitin represent an alternative source of raw materials for textiles. The term plastics is used because these materials are rarely present as fibrous materials. The term bioplastics is not a defined term, as it is sometimes used for biodegradable plastics, but also for plastics made from renewable raw materials that are not biodegradable. A disadvantage of the plant origin of bioplastics is the fact that the cultivation of the required raw materials competes with the cultivation of food and animal feed. In the search for raw materials for bio-based polymer fibres and bioplastics, the recycling of food waste is therefore increasingly being considered. Some of this discarded food, or even its components, which are not intended for consumption, can be processed as organic raw materials into new textile fibres and leather substitute products. Due to the growing world population, which is moving more and more into the middle class, and the thus increasing world demand for fibre, the high resource throughput is the most pressing problem. Therefore, the real problem lies in consumption, based on short fashion cycles and a textile economy that has not been able to recycle so far. The sustainability of textile products is based on a durable product design with a recyclable raw material input.

## 4.2 Sustainable Knitting Production

MIRELA BLAGA AND MARLEN WAGNER

Knitting is the second largest and most widely used technique for making cloth by interlacing yarns, but it is a relatively modern technique developed 7000 years later than weaving. The knitting technique began its journey to produce stockings, hats and gloves, and for each of these products, warmth, softness and adaptability were desirable qualities. Depending on the direction of movement of the thread in the manufacture of the fabric, we distinguish two types of knitting - weft and warp knitting. In its long history, knitting, both by hand and by machine, has mainly produced two-dimensional fabrics, which were then transformed into a final product by cutting and sewing or linking. Recently, with the development of knitting machines, three-dimensional knitting has been used to produce lighter and softer fabrics by eliminating the process of sewing or linking. Newly developed automated industrial knitting machines are capable of producing advanced patterns and structures, including shaped and seamless, with greater ease, and are therefore widely used for mass production. Seamless garments have the advantage of low risk of defects and damage. The elimination of sewing allows for faster processing and high potential for knitting on demand. 3D knitting offers fit, comfort, ease and mobility.

Actually, knitting would have to be adapted and further developed to the circular economy and Industry 4.0 in terms of sustainability in order to be economically viable in the near future. In the context of sustainability, the knitting industry has focused on the reuse, recycling and recovery of raw materials and the reduction or even elimination of knitting waste. The focus is on knitting machines with environmentally friendly manufacturing processes that place less of a burden on people and the environment. Manufacturers and users have rethought processes, production and consumption volumes. Sustainable finishing processes have been developed. Knitting machines that offer environmentally friendly manufacturing techniques with less impact on people and the environment, and production processes that significantly reduce wasted time or unproductive time gaps between manufacturing phases, have been favoured. Increasing efficiency, i.e., increasing knitting speed, has also become an important issue.

To achieve sustainability, all players in the knitwear industry should contribute and find reliable solutions. Manufacturers have addressed key issues for sustainable knitwear production, such as:

- use of sustainable raw materials for knitwear production,
- reuse, recycling and upcycling of raw materials,
- reduction or even elimination of knitwear waste,

- implementation of energy-efficient technologies and minimization or avoidance of emissions, and
- the use of environmentally friendly chemicals.

Wholesalers and retailers should promote the business of sustainably produced knitwear. Consumers are very aware of sustainable products, but the purchase decision is still driven by price and not always by the environmental impact of the product. The sourcing department of knitting mills must carefully select raw materials for knitting. Sustainable bio-based or recycled yarns are necessary to reduce the carbon footprint and other environmental impacts. Sustainability testing should be mandatory for all knitted consumer goods to boost business.

This module outlines the general context of knitting technologies and focuses on sustainable developments in knitting, particularly in electronic flat knitting machines, as reflected in the authors' experiences. The readers will get familiar with the general trends regarding the sustainable knitting production, will understand the principle and categories of knitwear, will learn about the methods of producing knitted products and understand the sustainable aspects of knitting technology. Digitalization, which is an ongoing process in the knitwear industry and contributes to its sustainable future, is also discussed, and digital solutions that have recently become available in the knitwear industry are presented.

## 4.3 Dyeing and Printing in the Context of Sustainability

ANDREI BERTEA

The textile industry, which has an extremely long and rich history, has always had a significant impact on the world economy and the evolution of human society itself. The last 100 years have been marked by significant transformations: the discovery of synthetic dyes, the development of chemical fibres, and the emergence of new areas of textile use.

We are currently witnessing a growing concern about the increasingly complex issues of environmental protection. Concerns are justified by the worsening of pollution, often with a tendency to globalization (visible changes in the climate regime, ozone depletion, unprecedented deforestation, desertification and arid phenomena, severe soil erosion and land instability, reduced natural resources, increasing pollution and anthropization of important ecosystems), with special economic and social implications.

In this context, the textile industry is experiencing a significant process of greening and streamlining specific technologies. This process, present in all stages of textile

processing, has a special significance in the case of chemical textile finishing, responsible for the most significant environmental pollution of all the stages involved in the production of a textile product.

In the field of textile chemical processing, the problems are numerous. They are 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 (but not necessarily), the possibilities of wastewater recirculation. Discoloration solves one of the most difficult problems associated with textile wastewater (even if not the most serious), and often lays the groundwork for ensuring a process of recirculation of discoloured water, with many benefits in terms of obtaining savings (water, reagents, energy, etc.).

Synthetic dyes are an element present in the vast majority of sectors of daily life, contributing significantly to its quality. The variety of colours of the products we use has become indispensable for modern human. That is why synthetic dyes are essential to meet the ever-increasing requirements of variety of shades, resistance of paints, and brightness of colours. However, because of the large number and diversity of dyes demanded by the market, there has been a growing need to assess the impact that these dyes have on the environment and especially on water pollution. This is because, due to the not always very high degree of fixation, relatively high amounts of dyes end up in textile wastewater and, hence, in case of improper treatment, in watercourses.

The problems caused by dyes are to a small extent due to eco-toxicological considerations. However, a number of problems have been reported in this direction, usually solved by giving up the respective dyes.

Ecological design has gained significant over the last ten years, with increasing awareness of environmental issues in the industry. While the primary focus was on reducing pollution and the amount of waste produced, in recent years the focus has shifted from end-of-pipe approaches to overhauling technology as a whole to achieve the goals of reduced pollution and minimum quantities of waste. 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).

The environmental protection component of sustainable development in textiles is determined by both economic and environmental objectives, such as:

- the possibility to reduce production costs,
- high cost of water and costs and regulations related to waste disposal,

- energy costs,
- the need to reduce greenhouse gas emissions,
- consumer demand for organic textiles, and
- environmental requirements in the international market.

One approach to environmental issues associated with the dyeing and printing processes is to optimize existing technologies. Process efficiency is fundamentally linked to environmentally friendly technologies. Doing “more with less” is the first step to sustainability. The production of quality goods using less energy, raw materials and auxiliaries, with the generation of little and non-toxic waste naturally leads to an increase in companies’ profits, while also being beneficial for the environment.

A second way is to develop completely new dyeing and printing technologies, which ensure low water consumption, reduce the consumption of chemical auxiliaries, achieve a high degree of dye fixation and, consequently, protect the environment.

Even though important steps have been taken to ensure the sustainability of textile dyeing and printing processes, there are still many aspects to be improved in the years to come.

## 4.4 Finishing in the Context of Sustainability

ANDREI BERTEA

Textile finishing is a way to add new functionality to the fabric so that it becomes suitable for uses that are not normally accessible. Finishing can improve the resistance to burning, to attack of microorganisms, the action of UV radiation, the ability to recover from wrinkling, and much more. The last years mark a significant increase in the demand for functional textiles, specially developed to achieve a certain final goal, such as self-cleaning capacity, superhydrophobicity, antimicrobial activity, etc. Most of these processes require water, energy and chemicals, and some of the chemicals used are not environmentally friendly. In recent years, research has been intensified for the development of sustainable textile finishing technologies, characterized by low environmental impact, minimal energy consumption and safety for users, using biopolymers, biomaterials and water-free technologies.

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.

Environmentally friendly products have replaced many chemicals, which have proven to be dangerous to the environment. Thus, halogenated flame retardants that have been commonly used have persistence in the environment, bioaccumulation and potential toxic effects on human health, and have therefore been replaced by halogen-free flame-retardants based on phosphorus-nitrogen (P – N), combined with other synergistic agents to prepare thermoplastic esters with good flame-retardant properties. Formaldehyde anti-crease products responsible for formaldehyde releases have been replaced with products that contain small amounts of formaldehyde or do not contain it at all, such as DMDHEU (dimethylol dihydroxy ethylene urea) or DMeDHEU (N, N'-Dimethyl- 4,5-dihydroxyethylene urea).

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. New finishing technologies aim to combine operations to achieve a variety of effects, such as anti-wrinkle, UV protection and antibacterial properties in a single step, using organic and inorganic chemicals that have a minimal impact on the environment.

Advanced, environmentally friendly textile finishing techniques include functionalization using nano-coatings, surface modification using hydrolysable silanes, microencapsulation, and increasing fibre strength using nano-coatings. Sol-gel coatings and layer-by-layer assemblies, depending on the composition of the sol-gel recipes and the type of layers deposited, allow for multifunctional treatments (e.g., flame retardancy, hydrophobicity, ability to conduct electricity).

Cold plasma treatments, which do not require the use of water, can be used in a wide range of situations, such as to activate the surface of the textile material or for coating and deposition to provide new functionality, water and oil resistance, fireproofing, protection UV or antistatic properties.

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.

## 4.5 Fashion Design in the Context of Sustainable Development of the Fashion and Textile Industry (Part 1)

ANTONELA CURTEZA

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. In the 2020 circular economy action plan, the European Commission announced the adoption of the EU Textile Strategy in 2021. In the European Parliament LEGISLATIVE TRAIN 11.2021 - 1 A EUROPEAN GREEN DEAL is stated: “The textile industry has also been identified as a priority sector for the EU’s move towards sustainability in the European Green Deal and the New Industrial Strategy for Europe, due to its high use of resources and high impact on the environment.”

Sustainability is a very complex phenomenon and approach, for which there is no single or general definition. According to Gurova and Morozova (2018, p. 2), the term ‘‘sustainable fashion’’ is used as an umbrella term for many approaches and practices such as: focusing on taking and returning resources, sourcing materials, treatment of fabrics, production methods, societal implications, saving resources, information transparency, and enhancing attachment and appreciation of sustainable fashion. According to Kozlowski et al. (2018, p. 195) sustainable fashion is also defined as “the profitable design, production, distribution, and end-of-life reuse, recycling, or disposal of fashion that supports circular systems, minimizes negative and maximizes positive impacts on both society and the natural environment”. 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.

Some researchers suggest that 70–80% of the environmental impact of today’s products, services, and infrastructures are determined in the design stage (Thackara, 2005; Brahma & Lofthouse, 2007; Esty & Winston, 2009). According to Wood (2007), designers are largely responsible for creating products that generate constant consumption, without considering other important aspects such as care or disposal. Many designers and product developers do not know or understand the negative environmental problems that occur in the entire process of design (Tomaney, 2005; Gwilt & Rissanen, 2011). The actual lack of proper approaches indicates that education is scarce and understanding sustainability is a very important subject area, and the proper corresponding approaches in design. The CFDA Guide to Sustainable Strategies – Materials (Leibowitz, 2019, p. 52) emphasized that: “Good design is sustainable, so sustainability must start with the designer.” According to the Sustainable Apparel Coalition: “The best moment to make low-impact choices about materials and production is at the beginning of the creative process” (Leibowitz, 2019, p. 52).

Designers often reflect very little regarding possible negative consequences the design approach could have on the environment. Fashion designers need to explore potential approaches of how to transform and change the way in which the products are produced and consumed. It was suggested that most designers do not understand what needs to be changed, and how to change. Most designers do not seem to have a clear opinion as to whom sustainable practice should be primarily directed or where it might

have the greatest impact. The sustainable approaches and practices in designers' activity can: reduce the number of micro fibres released into the environment, reduce toxic waste and support animal rights, develop clothes that are distinct and unique, lead to less strain on the planet's resources, and do no harm to people. According to Pal (2014, p. 241), "Sustainable product design initiatives, such as ecologically intelligent design, product re-manufacture and reuse strategies, recycling and material transformation strategies, green product design etc., are essential to reduce the stake on the natural capital (water, chemicals, energy, raw materials)". At the same time, "they increase the economic benefits of the organizations as well" (Pal, 2014, p. 241).

Graham and Marci (2020) pointed out that now, the coronavirus pandemic has brought sustainability to the forefront. It demonstrates how fragile we are as human beings, and how our future health and happiness depend on a healthy environment. A sick planet makes people sick, and the fashion industry cannot afford to make the planet even sicker. On the contrary, the fashion and textile industry can make the planet healthier by trying to meet the UN's sustainable development goals as soon as possible. Industry and education can develop a more symbiotic relationship that can lead this industry to a sustainable future.

This module presents different sustainable concepts, approaches and practices in fashion and textile design, their particularities, and their importance in the future development of the industry.

## 4.6 Fashion Design in the Context of Sustainability (Part 2)

ZLATINA KAZLACHEVA

The presented topic is oriented to the slow fashion design based on the application of the long-life elements and sustainable proportions of the golden ratio and Fibonacci sequence.

Slow fashion is an aspect of sustainable fashion and is the opposite concept of fast fashion. The concept offers sustainable fashion solutions, which are based on new strategies for design, manufacturing, consumption, use and reuse and thereby challenge the current global fashion system. Slow fashion involves a fashion awareness of the production and resources required to create clothing. while promoting the purchase of higher-quality clothes with trendless designs that will last longer, and fair treatment of people, animals, and the environment.

The trendless designs are based on the application of the long-life fashion elements.

A study of women's fashion of the last decade of the 20th century and the 21st century from the beginning till now shows that there are elements, which stay in fashion for a longer period of time, or in other words, they are always in trend. The application of durable fashion elements in design is a precondition for the long life of clothes. These elements are drapes, other 3D elements, peplums, and non-volume silhouettes.

Drapes took their place in contemporary fashion in the first half of the 20th century. Then, Mariano Fortuny created his draped, inspired by ancient Greek costumes evening dresses called "Delphos". A little later, the draperies have been developed in the creativity of Madeleine Vionnet and Madame Grès. Madeleine Vionnet is called the "Queen of the bias cut" as she introduced the bias cut to fashion design. Madame Grès has been called the "Queen of the drapery" and the "Master of the wrapped and draped dress".

Other 3D elements, which are the tucks, pleats, gathers, and ruffles, came into contemporary fashion at the same time.

The peplum comes in contemporary fashion from the ancient Greek overdress "peplos". Mariano Fortuny has been inspired not only by drapes in ancient Greek costumes but by peplos too. Peplums have also been seen in Christian Dior's "New Look" designs.

Non-volume silhouettes are always in fashion.

There are present designs such as the following examples:

- All types of drapes: free drapery, drape, formed with a seam or darts, twist knot drape, or drapery, fixed in a knot; and twisted drapery.
- Peplums, combined with 3D elements.
- Combined silhouettes based on non-volume and volume silhouettes shaped with the help of drapes, 3D elements and peplums.

When creating sustainable fashion products, the designers must not compromise on the application of the design principles.

There are many examples of zero-waste fashion designs, upcycled designs, circular designs, etc., which have a low aesthetic value. The balance has to be found between a sustainable fashion conception and the application of the design principles, which are symmetrical and asymmetrical balance, proportions, rhythm, emphasis, and unity.

The principle of proportion is strongly connected with sustainability. The proportions in combination with symmetrical or asymmetrical balance determine the next principles of rhythm, emphasis, and unity.

The Golden ratio and Fibonacci sequence are applied as proportions in design as expressions of beauty and harmony and they are a result of strong connections in their mathematical nature. The golden ratio has been applied as a harmonic proportion in art and architecture since ancient times. In more recent times, the relations between Fibonacci numbers have been also beginning to be used as harmonic proportions. Therefore, the proportional relations of the golden ratio and the Fibonacci sequence are the best examples of sustainable proportions.

There are present fashion designs of clothes, accessories and textile designs based on:

- A direct application of the golden ratio and the Fibonacci sequence as proportions,
- an application of geometrical figures based on the golden ratio and the Fibonacci sequence, and
- an application of tiles based on the golden ratio and the Fibonacci sequence.

A study on the long-life fashion elements shows some reasons for their sustainability in new design trends: They are of high aesthetic value and are elegant and feminine. They can be combined easily with each other or with other elements of fashion design.

The application of the sustainable golden ratio and the Fibonacci sequence proportions gives beauty, harmony and sustainability in the fashion design of clothes, accessories, and textiles. The use of the golden section and the Fibonacci series bring aesthetics in designs, based on different sustainable conceptions (zero-waste, upcycling, circular designs, etc.) and can be applied as an emphasizer of long-life fashion elements.

## 4.7 Pattern Making in the Context of Sustainability

ZLATINA KAZLACHEVA

The topic presents accurate and facilitated geometrical approaches of pattern making and pattern design examples of women's clothes with sustainable long-life fashion elements, sustainable proportions, minimizing and zero-waste cutting.

The slow fashion trendless designs are a result of the combinations of high-quality design, making of high-quality patterns, and high-quality fabrics and other materials. In other words, high-quality design, based on the long-life fashion elements, requires high accuracy of the geometrical constructional approaches used for pattern making. Geometrical approaches of accurate and facilitated pattern design of women's clothes with the four types of drapes are presented. The four types of drapes are: free drapery,

drape, formed with a seam or darts, twist knot drape, or drapery, fixed in a knot; and twisted drapery.

This lecture shows a constructional sequence of pattern making for women's clothes with peplums. Additionally, the application of the golden ratio and the Fibonacci sequence as sustainable proportions is presented. In most cases, they are applied in pattern making as direct proportioning or through geometrical figures. The figures are used as shapes of elements and pieces, or as a frame for forming shapes of elements and pieces. Examples of applying the golden section and the Fibonacci series in pattern making through direct use of geometric figures are shown. The geometric figures are the golden triangle, the golden rectangle, and the golden ellipse. Some designs combine the golden ratio and the Fibonacci sequence proportioning and long-life fashion elements of different types of drapes and other 3D elements.

Some pattern-making solutions offer lower consumption of textile material and thereby minimize waste cutting. With the help of these constructive solutions, minor design changes can be made while keeping the design's main idea. For example, the classic one-piece or two pieces sleeves in women's jackets can be replaced with drop shoulder ones. This change in the design and pattern making of a jacket leads to lower consumption of textile material and additionally minimizes cutting waste. Zero-waste fashion conception about design and pattern making, which eliminate cutting waste, offers interesting constructional ideas. For example, an idea for easy zero-waste cutting of A-line skirts, lower parts of dresses, or peplums is presented.

The accuracy of the presented approaches of pattern making of women's clothes with drapes is based on the correct and facilitated geometric sequences of constructing the four types and the correct and easy formulas, used for the twist knot and twisted draperies. The application of the formulas leads to the correct pattern design for all possible combinations of sizes of the elements of drapes.

The presented pattern designs are examples of sustainable and correct pattern making of women's clothes with sustainable long-life fashion elements of all types of drapes, peplums, and 3D elements, sustainable golden and Fibonacci sequence proportions through direct proportioning or geometric figures, lower consumption of textile material and minimizing waste cutting, zero-waste pattern cutting, and combinations between them.

## 4.8 Best Practices of Sustainable Product Development through 3D-Design and Visualization

MANUELA AVADANEI

*Digital technology* is and will be increasingly present in daily life. It will bring significant changes, improvements and challenges. The European Commission wants to bring about a significant shift towards a digitalised work and business life by 2030. Its goal is to achieve a climate-neutral Europe by 2050, which in turn will protect the planet and the population.

Europe's digital transformation amounts to "a digitally skilled population and highly skilled digital workforce, secure and sustainable digital infrastructures, the digital transformation of businesses and the digitisation of public services" (European Commission, 2023). New technologies and globalisation are opening up new avenues for consumption, production as well as commerce and are fundamentally changing a customer's behaviour. As a result, fashion companies need to adapt and revise their business methods to meet new demands, seize the opportunities of digitalisation, and ensure sustainable business success.

Companies will have a new, completely virtual structure that is able to face and adapt to the new situations: the different needs and requirements of customers, products and services.

*The digital approach to product development* facilitates collaboration work platforms, virtual meetings, and automated processes (as in finance). This technology provides the opportunity to improve the relationship with the customers. The company receives customer feedback, analyses their ideas and suggestions, and has the opportunity to identify where and how to make changes, if necessary.

A digital business transformation must be based on sustainable principles. This involves collaborative methods for capturing transdisciplinary knowledge: the need to link research and practice; data collection efforts and social considerations; collaborative planning to harness the power of digitisation and artificial intelligence (Gupta, 2020).

The latest research in the field of digitalisation and artificial intelligence concludes that "there must be a matrix between them, called Digitainability" (Gupta, 2020).

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.

The prospect of 3D simulation technology is promising for fashion designers and fashion education. A good example of how 3D simulations can be used in the fashion industry is the hyper-realistic presentation of designer collections.

The digital evaluation of the fitting degree of a garment product is very accurate in 3D simulations. There are two methods of simulating garments models: geometric and physically based models. Physically based models are more realistic and easier to implement compared to geometric models.

Using 3D technology to develop new models has the following advantages: design changes made in 2D or 3D are immediately visible in both the pattern and simulation, 3D simulated garments better reflect what products look like in reality, the 2D pattern can be plotted and used to manufacture the garment product, and the simulated garment is visible from all angles, allowing designers to view the model and make adjustments as needed. In this way, errors in fit, prints, proportions, balance, and shaped construction lines can be corrected more quickly. Changes are made relatively quickly, and the process is self-correcting. Fabric drape can be assessed and adjusted from a fabric library, quick and accurate positioning and scaling of prints, logos, and other details as well as new ideas can be quickly tried out, and the changes can be immediately visualised. Complex garment shapes can be visualised as well, and fabrics are available in unlimited quantities.

Designing becomes a digital, iterative process where variations and unexpected outcomes inspire and stimulate designers' creativity and imagination. It also becomes self-directed. Interaction with CAD helps the designer see the "rest" of the model and learn about the design in the final phase of the 3D stage. In summary, product development through 3D methods helps designers improve the evaluation efficiency of conceptual model creation to better support interactive design activities for apparel displays.

## 4.9 Clothing Technology and Production Methods in the Context of Sustainability

DIANA BALABANOVA

Sustainable manufacturing evolved from the concept of sustainable development, which was coined in the 1980s to address concerns about environmental impact, economic development, globalization, inequities and other factors. Sustainable clothing

production is a philosophy that promotes environmental and social responsibility. The apparel industry accounts for 10% of global carbon emissions. More sustainable apparel production can therefore significantly contribute to more sustainable economies (Blackburn, 2015). A sustainable manufacturing system focuses on a product that has been designed by introducing environmental factors (eco-design) while also taking into account not only the stage of manufacturing but also all stages of the cycle of life, from the procurement of resources to the product's final treatment and recycling. The objective seeking a sustainable production system is mainly environmental sustainability and the balance in manufacturing systems to maintain and even improve the quality of life of present generations without causing irreparable damage to the ecosystem. This is the base of industrial ecology and can be used for future generations. The origin of this evolution towards the search for a sustainable production system is determined by social sustainability, the protection of workers and the maintenance of the environment, using instruments such as legislation and decisions adopted by consensus of almost all world governments. In order to achieve economic sustainability, the integration of sustainable manufacturing must be done at a global level and at all hierarchical levels of a company where the application of sustainability factors for the efficiency of the production process takes place.

This lecture presents the distinctive features of sports-functional apparel manufacturing and the development of assembly technologies such as sewing, welding and gluing, along with the upcoming challenges in this field (Anand, 2011). New technologies for the production of sports-functional clothing fabrics are presented (Sewport Support Team, 2023).

New technological developments in the field of raw material and assembling technologies play a significant role in the evolution of functional clothing (Penkova & Pantulova, 2018).

Functional garments, like conventional garments, are made up by joining several pattern pieces together. These pieces, in turn, are joined with accessories comprising membranes, linings, buttons, zippers, tapes and waddings, to create a composite garment. The quality of the seam in terms of strength, flexibility, elasticity, appearance, comfort and permeability can have a significant effect on the quality and performance of the garment assembly.

The correct choice of the seam is therefore critical in the case of performance wear (Jana, 2011). The most common and conventional method of joining fabrics is by sewing with needles and threads. These seams can be used in garments made from porous fabrics. If the garment is made from nonporous materials such as those used for waterproof, fire resistant or chemical resistant clothing, the perforations caused by a

conventional sewn seam will compromise the integrity and performance of the garment. For such applications, therefore, either the sewn seams are sealed with tapes or entirely new technologies based on welding and bonding of layers are being employed to create fully sealed seams.

Some newer methods of sewing being used to join technical textiles include one-sided sewing technologies such as blind stitching.

Combining natural and synthetic materials in apparel products caused problems with material recovery, reuse, recycling, or composting at the end of product life. The concept of disassembly design and its application to the designing and making of men's jackets are presented (Gam et al., 2011). With this type of design, consumers and manufacturers can easily compost, recycle, or reuse different materials and components at the end of the garment's usable life (Rosen & Kishawy, 2012).

The presented clothing technologies for sustainable sportswear production offer examples to search for new ideas for sustainable clothing technologies and realize new fashion designs with minimal environmental footprint (Otero et al., 2011).

## 4.10 Social Health and Environmental Impact of Textile and Apparel Manufacturing Processes

DIRK HÖFER

The textile and apparel industry in developing countries contributes a lot to the growth of the economy and plays an important role in providing employment to the rural and urban population. Besides this positive economic impact, it still exposes textile workers in many textile and apparel manufacturing processes to occupational health risks. Although the organisation of the production process has changed in recent years, the safety and health hazards in the industry remain the same due to the lack of respective standards. The hazards in the textile and clothing industry are widespread and include mechanical, physical, chemical, ergonomic and physiological hazards, such as exposure to cotton dust, exposure to chemicals, noise and ergonomics issues, etc. There are also some factors that are responsible to create further hazards in the working environment, i.e., job strain, improper use of personal protective equipment, stress, unhealthy working environment with low lighting and high humidity and poor working conditions. Furthermore, today's fast fashion deadlines create a climate of harassment and violence in Asian factories. The various workplace hazards, risks and resulting diseases as well as harassment especially against female garment workers will be discussed elaborately in this lecture.

The textile industry, for instance, consumes numerous chemicals in the manufacturing and processing of textiles associated with operations such as desizing, mercerization, scouring, bleaching, dyeing, finishing and laundering. Particularly in the wet processing of textiles, chemicals make up about 70% of pollution in the industry. There are numerous health and safety issues and chemical accidents arising each year from the exposure of textile workers to hazardous chemicals and enzymes that are associated with processes such as fibre synthesis, weaving and wet processing. How these chemicals influence the overall environment as well as the human ecology during textile processing methods will be disclosed in this course.

In recent years, a clearer understanding of the chemical hazards paved the way for regulations by governments of countries across the globe and the introduction of eco-labels, both by the government and the industry. However, governmental regulations concerning workplace safety are still lagging, even after the Rana Plaza building disaster in 2013. Despite real improvements, there are still many shortcomings in terms of labour relations and control. As education is a fundamental human right, that is settled in the UN's Sustainable Development Goal No. 4 and helps the growth of a nation, it is essential that textile workers are aware of the various occupational hazards. However, employees in developing countries still suffer from a lack of education regarding occupational safety. Instead, textile workers are uneducated, often illiterate and most of them do not know what protective measures should be adopted for their jobs. Therefore, it is necessary that the management takes the necessary steps to protect workers from potentially hazardous situations and to foster education and health as a key component of human development. At least, informal education would help textile workers to gain knowledge about their medical rights, legal and social behaviour.

Despite that, consumers in high-income countries play a major role in supporting companies and practices that minimise their negative impact on textile workers' health and the environment. Efforts to make clothing more sustainable require acceptance by consumers with possibilities for several courses of action like raising consumer awareness, increasing transparency and eco-labelling as well as implementing precise textile care and recycling instructions to extend the longevity of clothes. In conclusion, though chemicals and textiles are inseparable, sustainable approaches should be encouraged and implemented throughout the textile and fashion sector.

## 4.11 Selected Student Projects at Partner Universities (Part 1)

ANTONELA CURTEZA

The module briefly presents the studies developed by students from the master's studies specializing in modelling and clothing design, within the discipline of sustainability in fashion. Each of the 3 studies is a unique approach to some current and pressing aspects regarding sustainable development in fashion.

### Study 1

Through the lens of the author, Camelia-Andreea Teodorescu, sustainability is a way of living and includes consumer education itself, promotion of personal style regardless of trends, awareness of environmental issues, appreciation and support of sustainable fashion producers, and above all identity and status for the good of the self. The consumer is the key factor when it comes to sustainability. From a psychological point of view, the consumer is subject to social stress when it comes to clothing. Promoting trends has become a social norm, and not belonging to these trends, which otherwise change much too quickly, make the consumer dependent on fashion, but not on defining one's own, different style. These rapid trends lowered the self-esteem of consumers and made them feel as if they did not fit into society when they do not wear the appropriate fashion trends. In this context, the student's collection was developed around the concept of personalizing worn/used clothing through handmade painting. Personalizing clothing gives a sense of uniqueness, makes the wearer feel special, reinforces the sense of identity and creates a more personal experience.

### Study 2

The project carried out by Roxana Pohata proposes the practical as well as aesthetic exploitation of the concept of textile waste recycling. In the idea of supporting the "recycle, upcycle & sustainable" triad, although paradoxical as a term in the context of sustainable fashion, the student brings in the use of a technique that allows continuous reuse in a productive vision. Upcycling includes performing value-added activity on disassembled material or clothing in such a way as to create a product of greater quality or value than the original. Under the name "Revive Project", the collection aims to reuse or convert fabrics into new fashion products, a theme that is part of the creative practice of any designer. The manipulation of different fabrics with various contrasting textures is proposed with the idea of generating wearable and sustainable fashion. The reintegration of textile waste into an experimental-creative collection is proposed, representing a challenge in finding both technical and aesthetic solutions. The student intensively explores the contrast resulting from the mixing of fabrics such as knitwear, organza, tulle, and the ultra-feminine aspect of cuts and volume.

**Study 3**

Maria-Mirabela Joandra's study highlights the fact that sustainable fashion is a design philosophy and a movement that promotes the environment and social responsibility. We can also talk about sustainability in terms of the old manual techniques for obtaining textile products. Today, manual activities receive a global re-appreciation, being generically defined as HANDMADE. Craft means both trade, profession, and skill, ability, talent. Crafts, regardless of their nature, combine the practical spirit with the need for beauty and the aesthetic sense manifested by human in their development. The "philosophy" that hides behind authentic craft products refers to perennial values such as kindness, love of neighbour, patience, faith or communion between everyone and everything. The basic idea was to create a clothing collection that recycle lace. The technique used for this collection is to attach lace elements to the tulle and bind them by felting with non-spun, coloured wool. The collection includes eight stylized models, in which lace elements are superimposed with felted surfaces. All designs are decorated with shapes made by felting directly on the lace and embellished with wooden beads to keep the vintage style.

As conclusions resulting from the works presented, it can be said that fashion is no longer about buying what's on trend and ending up with piles of clothes that will struggle to see the light of day after being worn just once or not at all. These clothes that we buy on impulse only end up adding to the existing and ever-growing waste in landfills and seriously harming the ecosystem. We have to take a conscious step in the future to stop encouraging the concept of Fast Fashion which has had a strong impact on the ecosystem and life in general, and move closer to more sustainable fashion, a trend that is healthier for the planet and future generations.

## 4.12 Selected Student Projects at Partner Universities (Part 2)

ZLATINA KAZLACHEVA

Previous topics about fashion design and pattern making in the context of sustainability introduce materials about long-life fashion elements, pattern making of slow fashion clothes, sustainable proportions, and zero or minimizing waste pattern design:

Long-life fashion elements stay in fashion for a longer period or in other words they are always in trend. The application of these elements in design is a precondition for the long life of clothes (slow fashion). These elements are:

- Drapes. Draperies are always in fashion. The free and twist knot ones are the most popular types of drapes.
- Other 3D elements. Tucks, pleats, gathers, and ruffles have a long life in fashion.

- Peplums. Although they are not as popular as 10 years ago, they are still in fashion for a long time.
- Non volume silhouettes. They are always in trend.

The slow fashion design required a high level of quality of pattern making, which provides accurate geometrical construction and correct dimensioning.

Sustainable fashion design is supported by sustainable proportion, as the more sustainable ones are based on the golden ratio and the Fibonacci numbers. The golden section and the Fibonacci sequence can be applied in proportioning in clothing directly, or by applying geometrical figures and tiles in their proportions.

The zero or minimizing waste conception has to be applied without compromising the quality of fashion design and pattern making.

For more successful sustainable fashion design, the application of long-life fashion elements, the correct pattern making, the sustainable proportions, and the possibilities for zero or minimizing waste can be combined.

This lecture presents selected results of PhD and master's theses in the fields of fashion design and pattern making of PhD and master's degree students at the Faculty of Technologies of Yambol, Trakia University of Stara Zagora, Bulgaria:

- Improvement of constructional approaches of pattern design of women's clothes with symmetric and asymmetric draped necklines with dependences on dimensioning the neck openings.
- Adaptation of the equation of sizing symmetric neckline for golden proportion between the width and depth of the neck opening.
- Adaptation of a geometrical approach to pattern making of women's clothes with twist knot drape for knitted fabrics.
- Development of a constructional approach to pattern design of women's twist clothes.
- Design and pattern making of women's dresses with peplums, which are combined with different types of 3D elements.
- Minimizing waste designs of women's dresses with the application of the golden ratio and the Fibonacci series tiles.

The presented students' projects on sustainable design and pattern making of women's clothes can be seen as examples of the development of new ideas and the

creation of new slow fashion designs with different types of long-life elements, golden and Fibonacci proportions, minimizing waste, and combinations between them.

## 4.13 Chances and Risks of Sustainable Textile and Clothing Production in the European Market

MANUELA AVADANAI AND MIRELA BLAGA

The fashion and clothing industry is one of the most innovative sectors in Europe. These industries form interconnected value chains from the design and manufacture of textiles (along with textiles, clothing, footwear, leather products, fur products, jewellery and accessories) to their distribution and retailing. Despite this fact, this industry has to deal with political conflicts, financial and economic crises, climate change, dwindling of natural resources, population migration, development of production technology (automation, robotisation), dynamics of jobs, consumer behaviour and profiles, etc. Production is prone to disruption from all-natural disasters. Outsourcing production means that relationships and communication are key to mitigating risks related to quality control, delivery reliability, etc. Short seasons for fashion items mean that the logistics of supply are critical to the success or failure of businesses. Many fashion retailers operate with very low inventories and use responsive manufacturing techniques that improve overall efficiency but also put additional strain on the supply chain. The international flow of fashion goods and the resulting “virtual company networks” are in many respects similar to high-tech supply chains in their complexity. So, where there are still manufacturers in Europe, they tend to outsource the labour-intensive parts of the manufacturing process to low-wage countries. This differs slightly from retailers who buy goods directly from cheaper long-distance suppliers, as subcontractors are integrated into the manufacturer’s internal supply chain. The fashion and apparel industry must constantly reinvent its business models in the face of currency pressures resulting from trade liberalisation, increased external competition, technological advances, adjustments in manufacturing costs and environmental concerns.

Under these conditions, the European Commission has launched a new programme aimed at implementing sustainability principles in the textile and clothing industry. This action can have a huge impact on fashion companies and aims to create a greener, more competitive sector by transforming the way textiles are produced and consumed. It will introduce new layout requirements, greenwashing regulations, regulations to prevent overproduction and overconsumption, and numerous new projects that will impact the business as a fashion employer.

The idea of sustainability has become a powerful word that brings some changes. Consumers are now taking a closer look at the foods they consume and the chemicals they put in their bodies. They are also changing their purchasing decisions by choosing items that can define a cleaner environment. Some fashion brands are aware of their unsustainable practices, but it is not easy for them to change. Nonetheless, consumer demand for ethical products is already forcing the fashion industry to adapt, as evidenced by the increasing number of campaigns promoting sustainable practices in the fashion industry.

In summary, this module provides a general description of the specific challenges of the fashion and apparel industry. It offers insights on transforming it into a sustainable one, where the items are manufactured with minimal environmental impact.

## 4.14 Summary, Reflection and Outlook – Part 2

MIRELA BLAGA AND ZLATINA KAZLACHEVA

The textile industry in Europe includes a wide range of products and processes such as spinning, knitting, weaving and finishing of textiles, followed by the production of industrial and technical textiles. All stakeholders in textile education are working to develop programmes that reflect the modernity of these industries and the wide variety of career opportunities they offer today. The workforce is the greatest asset of the textile and apparel industry, which must preserve existing know-how. This, however, is only possible if it employs qualified people.

Therefore, the lectures in the second part of the module ESD entitled "Sustainable Textile Technologies and Fashion in the European Market" aim to create awareness of the key issues of each topic related to the development of sustainable products. They are designed to improve teachers' professional skills and their content can be part of curricula at different educational levels or a valuable source of documentation for teachers.

This first topic focuses on information about classes of textile raw materials, as well as information about the global fibre market and statistics about megatrends. The unit provides a detailed description of natural and man-made fibres, their production, and existing categories, as well as a comprehensive presentation of existing sustainable fibre initiatives, projects, and programmes for those interested. The module's second lecture introduces the categories of knitting and the methods used to produce knitted fabrics. The sustainability aspects of knitting technology take a central place in the module and concrete solutions are highlighted. Digitalization, which is an ongoing process in the knitting industry and contributes to its sustainable future, is also discussed.

The third lecture addresses key sustainability issues in textile dyeing and printing, particularly the sustainability aspects of textile dye use. Readers will gain knowledge of revolutionary new printing technologies that are environmentally friendly. This continues in the fourth unit, which addresses key issues related to sustainability in textile finishing, such as high wastewater and water consumption, low-maintenance finishing and potential environmental risks associated with halogenated flame retardants. The presentation will provide information on the possibilities of optimizing existing technologies and replacing environmentally harmful products, as well as revolutionary eco-friendly finishing technologies.

Lectures five and six focus on the need for sustainable approaches in the fashion and textile industries and on sustainable fashion concepts. The role of design and fashion designers in sustainable development and useful tools for designing for sustainability are explained. Success stories and practices that can serve as inspirations for young designers are presented.

The seventh lecture explains how to make correct patterns for women's clothing with sustainable, long-lasting fashion elements of all types of draping using facilitated construction procedures and simple calculations, and how to make accurate patterns for women's clothing with the long-lasting fashion element of peplum. The eighth unit trains students to characterize product development for the mass customization fashion industry and presents sustainable solutions for product development in the fashion and apparel industry. The topic also informs trainees on how to characterize digital apparel development and describe best practices of sustainable product development for the fashion and apparel industry.

The ninth subject provides knowledge about the characterization of functional sportswear and the description of new technologies for functional sportswear. Thus, this subject trains students to characterize functional sportswear and describe new technologies in functional sportswear. The unit also teaches assembly technologies for functional sportswear and an understanding of the design and garment technology for disassembly.

Topic number ten addresses information on the environmental impact of textile and apparel manufacturing processes, on the health of society, as well as the physical, chemical, environmental, and occupational hazards in textile manufacturing processes.

In the eleventh unit, projects developed by students of the master's programme are presented. They are inspired by the concept of personalizing worn/used clothing through handmade painting, or integrating textile waste into an experimental creative collection, or stylizing models in which lace elements are overlaid with felted surfaces. In the twelfth

lecture, students are trained to design garments with sustainable, long-lasting fashion elements: draping, other 3D elements, and peplums, as well as garments with sustainable proportions based on the golden section and the Fibonacci sequence.

Lecture thirteen discusses the challenges and threats in the European textile and clothing market. The topic offers information on sustainability in textile and apparel production, which is hardly conceivable without the transformation from a predominantly linear economy to a consistent circular economy, the simultaneous reduction of overconsumption and the rapid reduction of $CO_2$ emissions.

Finally, the second part of the module ESD addresses its technical content to lecturers, teachers and trainers in higher education or vocational training, as well as to their students as future professionals in the textile and fashion industry. The outlook discusses the status and needs of the textile industry. It also presents teaching and learning approaches that can be adapted to the technical content to implement the principles of ESD.

# 5 Sustainability and Entrepreneurship in the European Market

## 5.1 Fashion Consumption in the European Market

MARCUS ADAM

Falling prices for clothes relative to other consumer goods, diminishing quality of apparel and a rise in households' disposable income have motivated consumers to shift from 'living without' to buying more fashion items over the last decades. This development has further accelerated through the advent of e-commerce and the opportunity to immediately and easily purchase various fashions from all over the world at a low price. This has resulted in a "throwaway culture" with many clothes being disposed of before their effective lifetime has ended.

Consumers have a nearly endless amount of opportunities nowadays. Products are quite similar and there are hardly significant differences in quality or price. Choices are based on more than traditional variables, thus, there are various factors that impact consumer decision-making. Consumers' decisions are found to be highly context dependent. Decisions can be difficult since there are many motives and options, conflicting values, difficult trade-offs, etc. Consumers try to find a compromise between the desire to make an accurate decision and the desire to minimize cognitive effort. Sometimes consumers prefer accurate decisions; other times easy, fast, justifiable choices are appreciated. Time pressure also affects how much information is gathered and processed. If consumers have time pressure, less information is searched for. Furthermore, emotions play a crucial role since they provide an immediate evaluation of the "goodness" or "badness" of a product or service. People especially rely on their emotions when the decision is difficult, when there is a limited amount of information or when they feel the emotions are relevant. Consumption is also used as an identity claim, a signal for values or a tool for regulating mood. The increasing power of social networks means that consumers' choices are based more and more on identity, gaining social currency and self-branding.

Consumers follow a certain process when deciding on the purchase of a product or service. One popular and comprehensive approach to depict the consumer decision process is the Engel-Kollat-Blackwell (EKB) Model which comprises five different stages: need recognition (consumers realize that they need something), information search (consumers start an information search about different alternatives to satisfy the need), alternative evaluation (consumers make a final decision and look for the best deal), purchase decision (consumers make a purchase intention to buy a certain product, but

may do not close a deal) and post-purchase (consumers evaluate and review the product).

Regarding the channel, online sales (after a previous strong increase) have entered a stagnation mode. However, with Covid coming up, online sales heavily increased. Overall, during the pandemic, all forms of fashion acquisition decreased. Consumers chose to spend less on apparel, reduce discounts and impulse purchases. Many consumers stopped buying clothes because they no longer felt the need to dress up. Furthermore, sustainable forms of fashion consumption such as ethically made and environmentally friendly new or second-hand apparel, swapping, renting, and tailoring apparel decreased.

## 5.2 Consumer Research

MARCUS ADAM

Companies must produce bundles of benefits that consumers will view as valuable. Developing and implementing a marketing strategy involves four stages: identifying and evaluating market opportunities, analysing market segments and selecting target markets, planning and implementing a marketing mix that will provide value to customers and meet organizational objectives, analysing firm performance. For this purpose, market research is conducted. Marketing research is the application of the scientific method in searching for the truth about marketing phenomena. In market research, researchers use the scientific method to gain objective conclusions as well as knowledge and evidence about the real world.

Marketers must consider measurement and attitude scaling, be familiar with different levels of scales, and understand the concept and the differences between reliability and validity. Market research can be conducted as qualitative or quantitative research. Qualitative marketing research addresses marketing objectives through techniques that allow the researcher to provide elaborate interpretations of market phenomena without depending on numerical measurement. Qualitative research is often used in an exploratory research context, e.g., in order to develop ideas or concept testing. This is useful when it is difficult to develop specific and actionable decision statements or research objectives, when the research objective is to develop a detailed and in-depth understanding of some phenomena, when the research objective is to learn how consumers use a product in its natural setting or to learn how to express some concept in colloquial terms, when the behaviour the researcher is studying is particularly context-dependent, or when a new approach to studying the problem is needed. Personal

interviews and focus group interviews are the most common method to collect qualitative data.

Quantitative research, on the other hand, addresses research objectives through empirical assessments that involve numerical measurement and statistical analysis. The most common method to collect quantitative data is surveys in different forms with multiple sets of different question types. Observations are another important tool in market research. The advantages of observations are that communication with respondents is not necessary, data is not distorted by self-report bias (e.g., without social desirability), there is no need to rely on respondents' memory, nonverbal behaviour data may be obtained, certain data may be obtained more quickly, environmental conditions may be recorded, and it may be combined with a survey to provide complementary evidence. However, observations have some limitations. They cannot observe cognitive phenomena such as attitudes, motivations, and preferences. Even though observations can describe the event that occurred, they cannot explain why the event occurred. Finally, the observation period generally is short because long periods are expensive or even impossible.

## 5.3 Impacts of E-commerce and Media on Sustainable Fashion

MARCUS ADAM AND JOCHEN STRÄHLE

Internet and mobile technologies have allowed greater communication between people in different countries. Accordingly, the accessibility of information has eased which opens up new opportunities for sustainable development as media can play a crucial role in this context. Media provide an understanding of geographical knowledge to people by reporting what is currently happening in which country and thereby inform about the background and impact of an event. Thus, media report and educate people about activities and behaviours that negatively impact our ecological environment and explain the reasons. Furthermore, media educate about environmental protection and spread sustainability information through different media channels (internet articles, printed articles, social media coverage, TV, online streams, podcasts and other audio formats…) to reach different groups in society. Media, moreover, disseminate vocational and professional information and educate people about the role they play within a society to empower them. Media can also create awareness of disastrous events in faraway parts of the world so that people in any country are quickly made aware of natural disasters and can provide help and/or donate. This is greatly needed since in some countries there is more development aid than government spending.

In order to report and educate people on sustainability, journalist of any media outlet need to be educated in sustainability themselves. This is challenging since the field of sustainability is complex and holistic with many diverse information and interrelated parts. Therefore, deep knowledge is needed. For this reason, sustainability has to be implemented in the curricula of any media and communication study program. However, the level of curricular integration of sustainability aspects in the field of media and communication is low. In most cases, sustainability remains an abstract guiding principle that is not translated into a dedicated course offer. Given the social relevance and responsibility of the discipline, sustainability communication should be more strongly institutionalized, in terms of curricular integration, and through the development of respective study programs.

With the advent of the internet and new technologies, e-commerce has appeared and plays a significant role today. It brings consumers the convenience to buy products at any place and at any time, allows them a great choice of products from all parts of the world, increases the availability of rare items, and opens business opportunities also for SMEs with tight budgets. The Covid-19 pandemic has further boosted online shopping since many physical stores were forced to start selling online. This trend is unlikely to be reversed in the future, however, brings along severe negative environmental impacts.

In general, there are three main categories of environmental effects of e-commerce: first-order effects, such as the availability of an ICT infrastructure required (PCs, mobile phones, servers, routers, etc.) which causes material flows, the use of hazardous substances, energy consumption, and electronic waste; second-order effects, such as productivity, transportation, land use, and third-order effects that result in rebound effects.

## 5.4 Global Textiles and Clothing Supply Chain

MARCUS ADAM AND JOCHEN STRÄHLE

Globalization is the process of interaction and integration among people, companies, and governments worldwide. Globalization has been taking place for hundreds of years but has sped up egregiously over the last half-century. Globalization has resulted in increased international trade, companies operating in more than one country, greater dependence on the global economy, freer movement of capital, goods, and services, and recognition of specific companies worldwide. Global sourcing strategies have emerged that involve worldwide geographically fragmented locations. In practice, apparel retailers approach their outsourcing and offshoring activities in three ways: direct sourcing, sourcing intermediaries, or sourcing hubs.

Global textiles and clothing supply chains are networks of businesses, individuals, organizations, and processes that are involved in the manufacture, transportation, and distribution of textiles and clothing. These networks are global and are composed of a variety of stakeholders, such as fabric and yarn producers, manufacturers, wholesalers, retailers, and consumers. The supply chain extends from the initial raw material suppliers to the final consumer. At the beginning of the supply chain, raw materials, such as cotton or wool, are sourced from suppliers. These raw materials are then processed into yarn and fabrics, which are then either sold as finished goods or used as part of the manufacturing process. The manufacturing process can involve spinning, weaving, dyeing, printing, and other processes. Finally, the finished goods are shipped to retailers who then sell the products to consumers.

Along the supply chain, numerous stakeholders are involved in the production and distribution of textiles and clothing. These include producers and suppliers of raw materials, textile and garment manufacturers, wholesalers, retailers, and consumers. Each of these stakeholders plays an important role in the global textiles and clothing supply chain.

The globalization of textile supply chains has a tremendous negative environmental impact. It has led to a high usage of chemicals in the producing countries and a high input of water which is often discharged unfiltered into waterways. Wastewater pollution has increased within the processing and raw materials stages due to the use of nutrients and fertilizers. Furthermore, long-distance transport is required to ship the finished products from the factories (located in low labour cost countries) to the consumer in a developed country.

In light of the globally dispersed apparel supply chain network, the intense involvement of lower-tier suppliers in apparel supply chains makes it complicated to manage environmental and social issues because the buying firms lack information and have less impact on lower-tier suppliers. Therefore, the operationalization of global supply chain networks (comprising multi-tier suppliers and stages) is a highly challenging task and needs strategic management actions.

Especially in the last couple of years, the global economic development poses new requirements for companies' supply chain management. Emerging challenges comprise demand volatility, production volatility, transportation issues, perishability, transparency, lead times, the availability of raw materials, and the popularity of fast fashion.

## 5.5 State of the Art in Globalisation and Industrialisation in the Textile and Clothing Industry

MARCUS ADAM AND JOCHEN STRÄHLE

Globalization is the process of interaction and integration among people, companies, and governments worldwide. Globalization has been taking place for hundreds of years but has sped up enormously over the last half-century. Thus, when talking about globalization, we usually refer to the global development from the 1970s until today. The globalization process has i.e., resulted in significantly increased international trade, companies operating in more than one country, greater dependence of every country and individual on the global economy, freer movement of capital, goods, services and humans, and the recognition of specific companies worldwide (global brands).

One reason for globalization is the significant decline of transport and communication costs over the last decades. As a result, exports of goods and services count for more than 25 percent of the global Gross Domestic Product today. This development has been accelerated through the establishment of intergovernmental organizations like the World Trade Organization (WTO), International Monetary Fund (IMF) or the United Nations Conference on Trade and Development (UNCTAD) that promote free trade between countries. While these economic institutions aim at fostering economic cooperation worldwide, a similar effort has been made regionally through multinational trading blocs. Trading blocs are a group of countries that decide to have common trading policies for the rest of the world in terms of tariffs and market access. Additionally, they give preferential treatment or benefits to each other within the bloc.

Another reason for globalization is the significant growth of the world population over the last decades which has led to a greater global workforce. Given the cheap transportation costs and the mitigated transnational trade barriers, this workforce can be globally accessed and utilized. The main profiteers of this development are especially the developed countries where wealth has increased while the annual working hours of individuals declined. The advent of the internet plays a further decisive role in globalization over the last two decades. This has led to the rise of e-commerce and the immediate availability of any product independent of its origin, to more intercultural and interpersonal exchange across borders, a reduction of prejudices between individuals and nations, and more flexibility for freely moving and working in different countries simultaneously. Furthermore, Foreign Direct Investment (FDI) is an important channel for the transfer of technology between countries and promotes international trade, can create jobs and skills for local people and the money created by investment can be spent on education, health and infrastructure.

However, globalization also has negative effects. Multinational Corporations (MNCs) with their massive economies of scale, may drive local companies out of business. If it becomes cheaper to operate in another country, the MNC might close the factory and make local people redundant. Furthermore, globalization has facilitated mass production and lead to overconsumption. Globalization is also viewed by many as a threat to the world's cultural diversity: It is feared it might drown out local economies, traditions and languages.

## 5.6 International Procurement of Textiles and Clothing for the European Retail Market

MARCUS ADAM AND JOCHEN STRÄHLE

The sustainability challenges of textile and clothing are very closely related to the rapid globalization of trade in recent decades. Arising opportunities and the severe global competition have motivated companies to put much effort into reducing manufacturing costs by outsourcing their production to developing countries with low wages.

In practice, apparel retailers approach their outsourcing and offshoring activities in three ways: through direct sourcing from suppliers, through sourcing intermediaries, or via sourcing hubs. The simplest way of sourcing directly from suppliers is through the headquarters of an apparel retailer which is in direct contact with its suppliers and hence obtains better control over the manufacturing process. Moreover, apparel retailers set up subsidiaries in the respective sourcing countries, so-called sourcing hubs/offices or international purchasing offices. Lastly, apparel retailers usually employ (import or export) sourcing intermediaries, also typically referred to as e.g., sourcing agents or full-service vendors who usually bridge apparel retailers in developed countries and manufacturers in developing countries. Governments in developing countries have been encouraged by international institutions to put economic growth before stronger environmental and social regulation.

The main problem in keeping the textile supply chain transparent for all its related actors is the extraordinary diversification of apparel products. Social movements and journalists collect experiences and document sweatshops as well as unsustainable production circumstances. This politicization threats the reputation of big brands and creates drivers for more sustainable sourcing strategies. As a result, resources are mobilized, collaborations developed, new standards issued, and eco-sourcing encouraged. On the other hand, the globally stretched, complex, and fragmented supply chains come along with enormous governance difficulties. Barriers to sustainable sourcing in the fashion industry are undersupply of sustainable raw materials, shortage

of superior quality raw materials, complex material structure and composition, weak partnerships and integration between partners, absence of suitable supplier training and reward system, and poor commitment and asymmetric information sharing from buyers/customers. Furthermore, costs of sustainable raw materials, rise in costs of investment, uncertain return on investment, costs of eco-friendly packaging, resistance to upskilling and knowledge sharing may lead to continued misunderstandings throughout the entire supply and demand chain. Other barriers comprise a lack of eco-literate and skilled employees, insufficient commitment from top management, hard transition to new business models, inadequate infrastructure, disperse customer perceptions, and limited support from governing authorities.

## 5.7 Supplier Relationships

MARCUS ADAM

Since the early 1970s and the development of globalization outsourcing gained increased attention. Outsourcing refers to arrangements between a company and its independent suppliers to manufacture components or to provide services according to defined specifications. Single or multiple steps of the manufacturing process can be transferred to a foreign contractual partner (pre-production, final production, refining or complete production). Benefits include cost savings (especially in labour-intensive production processes in low-wage countries), savings in taxation, lower energy costs, access to raw material, and the opportunity to concentrate on the firm's core competences (e.g., product design, marketing, etc.). This has led to complex networks that companies operate in.

Network theory serves as a suitable approach to understanding this complexity. It departs from the assumption that markets are constituted of networks. A network consists of a set of actors or nodes along with a set of ties of a specified type (such as friendship) that link them. The ties are interconnected through shared ends to form paths that indirectly link nodes that are not directly tied. The pattern of ties in a network yields a particular structure, and nodes occupy positions within this structure. This means that companies are not isolated but embedded and connected through relationships with other units or actors, which they exchange knowledge, goods or information with. Networks present essential conduits of information and know-how and provide firms with access to useful information and resources. This implies that a company is not able to implement a certain strategy completely independently but needs to consider other expectations, requirements, or opinions. Each network is characterized by a (potentially) varying network density which describes the degree of interconnection among the various parties within the network and represents the strength of relationships between different nodes.

Networks can be illustrated in the form of a map. It illustrates the relationships of the different parties within the environment of the respective firm. Network mapping helps companies to cope with relation complexity, helps to identify the differences and the most important linkages and nodes, and allows to build awareness of the company´s position. Looking at an illustration of its network will make it easier for a company to set the scope of its strategy and enable it to focus on business efforts.

Trustworthiness is essential to develop and maintain mutual, long-term relationships. When trust exists, uncertainty is reduced, and individuals are more willing to share resources and collaborate. Creating trust between partners is therefore a governance mechanism that undergirds the establishment of network ties. Trust may evolve from a cognitive or emotional direction.

The process of establishment and development of relationships over time can occur in incremental stages in their evolution. The stages are marked by factors that determine the reduction or increase of uncertainty and commitment between both parties. Establishing relationships is not an inevitably developing process, as there is no certainty for a company to evolve and proceed to the next stage. Instead, failure or regress of development might occur.

## 5.8 Social Risk Management in Fashion Supply Chains

MARCUS ADAM AND DENIZ KÖKSAL

Global sourcing gained increasing attention during the early seventies when the advantages of offshore production have been realized, particularly in terms of costs as the most dominant driving factor. The primary reasons for outsourcing and offshoring activities are lower prices, access to locally unavailable products, technologies, scarce resources, higher quality, an increase in supplier base, and the opportunities to develop a foreign market. This has led to different integration levels of sourcing ultimately resulting in global sourcing strategies that involve worldwide geographically fragmented locations. Therefore, the operationalization of global supply chain networks comprising multi-tier suppliers (first- and lower-tier suppliers) is a highly challenging task and needs strategic management actions calling for the need of Supply Chain Management (SCM) in order to achieve purely economic objectives: lower costs, increased customer value and satisfaction, and finally competitive advantage. Lower-tier suppliers are considered to be less responsive to social and environmental issues and have weak relationships with the downstream supply chain due to the complex and long supply chains. In general, there is a substantial lack of visibility as they indicate that apparel retailers might even not know

the suppliers who manufacture their garments. This can induce considerable social risks, such as the use of child labour.

The integration of economic, ecological and social aspects of business practices and the theory of SCM will result in Sustainable Supply Chain Management (SSCM). SSCM demands a broader perspective of SCM. One concept that concisely shaped the literature on sustainability and its operationalization is the assessment of a firm's performance under the umbrella of the triple bottom line (TBL), which recommends the simultaneous commitment to environmental, social, and economic dimensions. Managing sustainability risks and reputation, meeting consumer demands and stakeholder pressures, or gaining competitive advantages are among the primary motivations for focal companies to approach SSCM. However, there are notable barriers for efficient and effective SSCM such as higher costs, coordination complexity and insufficient or missing communication in the supply chain. Therefore, supplier evaluation requires specific governance mechanisms and supply chain management capabilities.

To specifically address social issues in the supply chain, the concept of Social Sustainable Supply Chain Management has emerged. It comprises three basic strategies that ultimately have an impact on social performance outcomes in supply chains: communication, supplier development, and compliance strategy. Social performance metrics addressed by Social Sustainable Supply Chain Management are particularly human rights, unfair wages, excessive working time, child/forced labour, unhealthy/dangerous working conditions, discrimination, diversity, and treatment of animals.

## 5.9 Best Practices of Sustainable Business Models

MARCUS ADAM AND JOCHEN STRÄHLE

Many clothes are disposed of before their effective lifetime has ended. This phenomenon is frequently referred to as "throwaway culture", a result of consumers' greed for constantly buying more fashion items and fashion retailers satisfying this hunger by permanently flooding the market with new clothes at very low prices.

Some fashion companies have started to address these challenges by applying eco-friendly technologies and integrating sustainability aspects into their supply chain management. However, as these approaches have turned out to be insufficient to achieve an environmentally sustainable transformation of the fashion industry, sustainable business models have increasingly gained attention. In this context, Product-Service Systems (PSS) have emerged as a potential way of solving the sustainability challenge. Instead of selling solely tangible products, PSS shift the focus to fulfilling customers' final

needs by offering complementary service elements. This decouples customer satisfaction from material consumption and entails economic dematerialization as fewer products are manufactured and, hence, fewer resource and material inputs for corporate value creation are required.

The seminal tripartite classification of PSS divides PSS into three different types: (1) Product-oriented: Products are sold traditionally but supplemented by extra services, such as after-sales services, that ensure long-term functionality. Examples are repair services, offers to take back used garments or make-it-yourself models. (2) Use-oriented: The use or functionality of a product is sold while the ownership of the product remains at the company that offers it. Examples comprise models to rent, lease or swap clothes. (3) Result-oriented: The company sells a result, a capability, or a competency that underlies a product such as consultancy or digital clothes.

Especially a mushrooming of providers that offer services to rent clothes can be observed in the market today and gained popularity over the last years. These models significantly differ in terms of value proposition, channels and cost-revenue streams: Some firms directly rent clothes to customers for a certain period of time either for a fixed fee or a membership fee (e.g., monthly) via an online store. Others are fashion libraries that rent clothes through a permanent physical store. Furthermore, peer-to-peer renting (e.g., providers of online platforms) has seen a raise, and B2B offers (e.g., renting providers of working clothes) are already anchored in the clothing industry for a longer time.

Even though such initiatives have recently gained some attention, many barriers prevent consumers from renting fashion such as hygiene concerns, the stigma of used goods, predominant consumption habits, the lack of ownership inherent to renting, a general lack of trust in both the offer and the provider, and the overall benefit/cost ratio. Furthermore, there are internal organizational barriers that hamper PSS diffusion since PSS implementation calls for a fundamental conversion of existing corporate strategies, structures, and corporate cultures. Service offers significantly differ from the predominant way of manufacturing and selling clothes. Thus, even though, PSS present a promising solution for the industry’s environmental challenge, its future diffusion and potential remain uncertain.

## 5.10 Transparency in Fashion Business

MARCUS ADAM, JOCHEN STRÄHLE AND MALTE WESSELS

The fashion industry is extremely resource-intensive and causes significant environmental and social impacts. Many consumer studies indicate that consumers wish for more transparency regarding companies' impact on the environment and society.

Sustainability reporting in fashion businesses is an important step in ensuring that the company is responsibly managing its activities. It is a way of keeping track of the environmental, social and economic effects of a company's activities, products and services. Thus, it not only helps the business identify areas of improvement, but it also to understand the impact of its operations on the environment and people.

In recent years, more and more fashion firms have started to address this demand and disclose non-financial information about their business activities. Transparency involves the corporate disclosure of the names of the suppliers involved in producing the firm's products; information about the sustainability conditions within these suppliers' facilities and the buying firms' purchasing practices. Transparency also benefits the company as it reduces negative market signals regarding environmental and social impacts, facilitates the assessment of regulatory and voluntary compliance, and enhances the efficiency and quality of Sustainable Supply Chain Management (SSCM).

Until now, companies have been able to use different frameworks for their reporting, such as the German Sustainability Code or the standards of the Global Reporting Initiative (GRI). In order to improve the comparability and quality of sustainability reporting, companies are now required to use uniform reporting standards which, among other things, specify the information to be reported and the type of reporting (e.g., structure of the report). The standards will be issued by the EU Commission by way of delegated acts; for small and medium-sized enterprises (SMEs), standards are envisaged which consider the special features of these companies.

According to the revised Corporate Sustainability Reporting Directive (CSRD) by the EU, the group of companies that will have to report on non-financial aspects in the future is growing strongly. In principle, all companies listed on a regulated market in the EU (except micro-entities), as well as large non-capital-market-oriented companies and most banks and insurance companies, will be required to report on non-financial indicators in the future, thus contributing to greater transparency on sustainable aspects.

Overall, transparency in the fashion business is essential for both consumers and businesses alike. It helps to build trust between the two, and it also allows for better decision-making.

From a consumer perspective, transparency allows making informed decisions about the products. Knowing the materials and labour inputs that went into making a garment, for example, can help consumers make more ethical choices. Additionally, transparency helps protect consumers from exploitation and counterfeit goods.

From a business perspective, transparency can help with cost management, as well as improving processes, such as supply chain management. This way, businesses can ensure that their processes are efficient and that their products are of high quality.

## 5.11 Green Fashion Retail Strategies

MARCUS ADAM AND JOCHEN STRÄHLE

Fastness, newness and cheapness have become the most critical determinants for success in the mainstream fashion industry. However, this business model is extremely resource-intensive and causes significant environmental impact. In recent years, more and more fashion firms have started to address this problem and adopted environmental standards to produce more sustainable clothes. To solve this challenge, a clearly defined and executed strategy is needed. Strategic management embraces the formulation and implementation of a company's major goals and initiatives on behalf of stakeholders. It is based on considering resources and assessing the internal and external environments in which the company operates. Strategies are needed to set direction, focus effort and the company, and provide consistency or guidance in response to environmental changes.

Fashion retailers that want to implement a sustainability system in their stores need to develop a clear long-term-oriented strategy and define a plan of action to meet the strived goal. Different data should be monitored and analysed based on this strategy to prioritize efficiency initiatives by return on investment. This includes ongoing reports on contracts, market changes and opportunities. Next, energy assessments in a sample of stores should be deployed. Stores have to be organised in categories, such as building type and age, or by equipment that is installed. To be able to prepare wide visibility into disparate data sources to internal and external stakeholders, energy and resource consumption data must be collected and reports need to be generated. In a next step, energy and resource data must be aggregated, centralized in a software and reviewed by remote energy experts to discover inefficiencies and recommend initiatives to optimize processes or equipment. Finally, supplier information should be analysed in order to identify potential risks.

Another strategic approach towards sustainable retail is the development and implementation of Product-Service Systems (PSS). Instead of selling solely tangible products, PSS focus on fulfilling final customer needs by offering complementary service

elements. PSS contradict the traditional, linear fashion business model: Implementation requires new distribution channels, revenue streams, logistics and expertise. Mastering two incompatible business models is challenging and involves the risk of establishing tomorrow's business at the expense of today's, especially as the present business model is working well for most fashion firms. This trade-off is referred to as "ambidexterity". There are two basic strategic approaches to solving this challenge. First, spatial separation can be used, which means that the PSS business model is put into an autonomous and independent unit with its own brand name, value chain, and organizational structures. The second strategic approach is temporal separation: The PSS business could be started in a separate unit and gradually be integrated into the main business over time.

## 5.12 New Strategies for Sustainable Textiles and Fashion in the European Market

MARCUS ADAM

The fashion industry calls for new sustainable solutions to improve its ecological footprints. The predominant business model of today's fashion industry is based on product obsolescence, with fashion retailers constantly presenting new fashion lines at low prices to a mass market. This causes significant environmental consequences as it implies high input of energy, water, pesticides, and harmful chemicals and generates vast volumes of waste. Furthermore, it promotes a "throwaway culture" among consumers with garments being disposed of and replaced before their effective lifetime has ended. In recent years, more and more fashion firms have started to address this problem and adopted different Corporate Sustainability (CS) initiatives. These approaches vary a lot regarding commitment and engagement, from "greenwashing" to strategies that aim at transforming the predominant way to do business.

Advanced Corporate Sustainability strategies of organizations are based on different cornerstones such as transparency, comprehensive communication, disclosure of nonfinancial information, stakeholder dialogue, tolerance for failure, and organizational learning. Particularly employees play a decisive role in CS. A company cannot exist without employees: they need to support the CS directive and put it into actual practice. Huge potential for CS lies in employees: Many live a sustainable lifestyle in their private lives and like to transfer their way of living to their professional life. Furthermore, employees are the major point of intersection between firms and customers and thus represent the firms' values in the eye of the customer. If an organization wants to be recognized as sustainable and educate its customers towards more sustainable behaviour, it is largely up to the employees to transfer sustainable values and attitudes to

the customers in a credible way. This especially applies to firms with a business model that is based on a significant service component, like fashion retailers. Furthermore, many employees bring in a lot of education and experience that could and should be exploited in order to successfully restructure an organization towards more sustainability. Thus, the intrinsic motivation of employees is a critical determinant for CS implementation. To optimally nurture and elicit the intrinsic motivation of employees, firms with advanced CS have adopted various HR practices, such as staffing, training, rewards, career opportunities, employment security, profit-sharing and participation.

On a more generic level, the implementation of business models, such as Product-Service Systems or Circular Economy models, are expedient ways to strategically transform the organization towards sustainability. Firms that move in this direction firstly need to create an intelligent product design and collaborate closely with partners for this purpose. This is challenging, as companies are generally not used to interacting with companies in such ways but are rather focused on direct supplier or customer relationships. Secondly, firms need to dive deep into their own and their partners' production processes and customer activities to understand the ecological footprint. This includes tapping into new technologies and patterns like reparability, local production, and the use of renewable energies. Thirdly, firms need to monetize the approach and develop performance-based contracting revenue models. Finally, firms have to find ways to excite the model by creating new and attractive value propositions for the customer.

## 5.13 Chances and Risks of Slow Fashion Strategies and a Circular Economy in the European Market

MARCUS ADAM AND JOCHEN STRÄHLE

Slow fashion is a way to "identify sustainable fashion solutions, based on the repositioning of strategies of design, production, consumption, use, and reuse, which are emerging alongside the global fashion system, and are posing a potential challenge to it" (Clark, 2008, p. 428). This quote shows that slow fashion is an approach to fashion that is based on sustainability. It is an eco-friendly approach to fashion that focuses on the slow production and consumption of clothing. The goal of slow fashion is to reduce the environmental and social impact of the fashion industry by focusing on sustainable production and consumption practices. This includes promoting the use of natural and organic materials, reducing waste, and creating ethical working conditions for employees.

Most products are not designed for durability. Our current economic system is based on fast product replacement, planned obsolescence, low unit prices and low quality, thus, it is no longer worthwhile to repair products. However, products and material possessions

play an important role. They represent our personality, social standing, wealth, values, history and relationships with others. They are expressions of our identity, sexuality, sociality, and of our aspired lifestyle. Furthermore, they are connected to emotions. Emotions related to consumption are sparked before and after the purchase event. Consumers may develop emotional attachments to some objects but not to others. If an emotional attachment exists, consumers are unlikely to dispose of the product soon after purchase. Instead, consumers care for the product and the product's longevity is increased.

Designers should find ways to foster the product-consumer attachment to lengthen the product lifespan. Empathic design is a concept that picks up this idea. It is based on observation and the identification of hidden customer needs. The purpose is to create products that the customers may not yet even know they desire, or create products that customers have difficulties to imagining because they are not familiar with new technological possibilities or create products that consumers cannot visualize because they are locked in a specific mindset.

This approach is closely connected to the development towards a Circular Economy. Firms that move in this direction firstly need to create an intelligent product design and collaborate closely with partners for this purpose. This is challenging, as companies are generally not used to interacting with companies in such ways but are rather focused on direct supplier or customer relationships. Secondly, firms need to dive deep into their own and their partners' production processes and customer activities to understand the ecological footprint. This includes tapping into new technologies and patterns like reparability, local production, and the use of renewable energies. Thirdly, firms need to monetize the approach and develop performance-based contracting revenue models. Finally, firms have to find ways to excite the model by creating new and attractive value propositions for the customer.

## 5.14 Summary, Reflection and Outlook – Part 3

MARCUS ADAM AND JOCHEN STRÄHLE

The fashion industry is a mature, extremely globalized and labor-intensive sector with strong competitive pressure, short life cycles and low predictability. Fashion has become a pervasive part of everyday life and has been linked to various negative effects. Firstly, fashion can be seen as a status symbol, which can lead to feelings of insecurity, competition, and jealousy. It can also create an unhealthy focus on one's appearance and body image, which can lead to eating disorders, depression, and anxiety. Furthermore, fashion trends often involve synthetic and toxic materials, such as polyvinyl

chloride (PVC), which can be detrimental to the environment and pose health risks to those who wear them. The production of clothing and accessories can also create a great deal of pollution, as the chemicals used in dyeing and finishing are released into the air and water supply.

Finally, the fashion industry is known for its exploitative labor practices, with workers in developing countries often facing long hours, low wages, and hazardous working conditions. This can lead to a lack of economic opportunity for those living in poverty and perpetuate social inequalities. Since the late 1990s and early 2000s fashion firms have started to more frequently refresh their fashion lines to meet the rapidly changing preferences of consumers. This trend has further accelerated through the emergence of e-commerce which provides consumers the unrestricted ability to immediately purchase new clothes. Retailers now constantly flood the market with new mass-produced fashion items that are fashionable, affordable and easily accessible for consumers who desire to follow the latest high fashion trends for a fraction of the traditional price. However, this business model is extremely resource-intensive and causes significant environmental impact.

The negative effects of fashion on the natural environment have further intensified through consumers' propensity to overconsumption and short-term use of clothes. The falling prices, the immediate availability and the deteriorated quality of fashion items have encouraged a "throwaway culture" among consumers with many clothes being disposed of before their effective lifetime has ended. In short, fashion can have many negative effects, from feelings of insecurity and competition to the exploitation of workers and damage to the environment. It is important to be aware of these potential risks and to take steps to ensure they are minimized.

The previous lectures gave a short overview of the most important underlying mechanisms and discussed them. After running through the lectures, students should have a basic understanding of the interaction between companies and consumers in a highly globalized world and why this causes severe negative impacts on the environment. Students should be able to reflect on the reasons and – based on this – discuss potential solutions. By doing so they contribute to the sustainable development of the fashion and textile industry.

# 6 Teaching and Learning Materials for ESD in General and Vocational Education

ANNE-MARIE GRUNDMEIER

In the face of climate change, species extinction and inequality of opportunity, the premise of sustainability has taken hold in all areas of society. In everyday life, this is expressed in diverse actions such as waste avoidance, upcycling and the use of renewable energies. In politics, it manifests itself in sustainability strategies, whereas the economy establishes sustainability through sustainability-oriented processes as well as ecological and fair products. Within the framework of a sustainable transformation, a reorientation of established production techniques and products, consumption patterns and lifestyles is demanded (United Nations, 2015).

On the one hand, companies are called upon to recognise sector-specific challenges to sustainability and to develop socially responsible solution strategies. For solving the key problem of leaving an ecologically, socially and economically intact world for future generations, the business world is of outstanding importance in developing and disseminating social and technological innovations to shape sustainability-oriented transformation processes. On the other hand, a green transformation cannot succeed without informed and sustainable consumers. Education in general – informal, non-formal and formal – as well as vocational education and training, therefore, have a key role to play.

To support pupils in classifying the relevance of their actions for the environment and society, targeted educational offers in the sense of Education for Sustainable Development (ESD) are needed. ESD represents a pedagogical action concept that is intended to enable pupils to make judgements and take action in everyday life and at work, and to make a contribution to shaping sustainable development. The didactic educational approach considers the three pillars of sustainability – ecology, economy and social issues – and is intended to bring about sustainable change.

Through educational and communication processes, challenges of sustainable development can be developed and reflected upon, an understanding of the complex, multi-layered interrelationships between ecological, economic, social, cultural and political conditions for sustainable development can be built up and deepened, knowledge can be acquired and reflected upon, and values and attitudes can be questioned. This can initiate or deepen a change in consciousness and contribute to the individual development of competencies that motivate people to get involved and enable them to responsibly shape the present and the future.

By means of the Agenda 21 (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 1992), an action programme was adopted that contains guidelines for sustainable development. Education at universities and schools is central to the implementation of these guidelines. After all, formal education aims to enable young people to shape the future – both for themselves and for them as part of the generation that will bear responsibility in the future. ESD is not to be understood as a subject of university or school teaching, but as a field of action into which knowledge from the subjects flows. Thus, ESD cannot replace the subjects studied and taught at school but is intended to connect to the knowledge acquired there in a variety of ways, enriching, expanding and re-contextualising it (Bundesministerium für Bildung und Forschung, n.d.).

ESD should enable learners to help shape sustainable development and to critically reflect on their actions in this regard. This requires individual competences that are to be promoted through ESD. On the one hand, ESD should impart basic knowledge on how to deal with key social problems. Learners should be enabled to recognise challenges and to find their own approaches and solutions, i.e., to acquire design competence (de Haan, 2008). Since ESD encompasses a technical, economic, political and social design mandate, design competence is the overarching learning objective. This is understood as the ability to apply knowledge about sustainable development and to recognise problems of non-sustainable development. It means being able to draw conclusions about ecological, economic and social developments in their interdependence from analyses of the present and studies of the future and being able to make and understand decisions based on these conclusions and to implement them individually, collectively and politically in order to realise sustainable development processes (Trempler et al., 2012).

For school education, various competence models exist to define core competences to be acquired in the context of ESD (Nagel et al., 2006). The Orientation Framework for Global Development Learning is directly connectable to competence-oriented subject teaching (Schreiber & Siege, 2016). This defines eleven core competences that can be assigned to the three competence areas of recognising, evaluating and acting. In empirical social research, there is the approach of seeing environmental behaviour as part of lifestyles and consumption patterns. After all, lifestyles, consumption patterns and specific interest preferences are considered essential for environmental awareness and behaviour. Although young people are shown to have a comprehensive awareness of sustainability (BMUV & UBA, 2021), studies also show a discrepancy between their environmental knowledge and environmental actions in the fashion sector (Wahnbaeck & Groth, 2015) and confirm the attitude-behaviour gap (Wiederhold & Martinez, 2018). According to a representative survey of 14- to 22-year-olds living in Germany by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection and the Federal Environment Agency, sustainable consumption behaviour is becoming increasingly important, which is reflected, for example, in the

consumption of organic and fair-trade products as well as through sharing activities or the purchase of second-hand goods (BMUV & UBA, 2021, pp. 32-33). Against this backdrop, addressing sustainable textile and clothing consumption is very significant.

Overall, 40 percent of young people in Germany are thinking about how they can behave in a more climate-friendly way. 37 percent are more concerned about the future, 34 percent are trying to get friends and family to act in a more climate-friendly way and 28 percent want to get (even) more involved in environmental and climate protection in the future (BMUV & UBA, 2021). It is therefore important to present students with sustainable, feasible options for action or motivating solutions. This finding is supported by Ojala's study saying that teachers should take students' emotions seriously and communicate in a forward-looking, positive and solution-oriented way. Through this style of communication and taking emotions seriously, the students should feel more "constructive hope", which, in contrast to "hope on denial", can be associated with environmentally friendly behaviour and increased commitment (Ojala, 2015). Empathy is therefore of great importance for sustainable action. Finally, researchers have confirmed that empathy is one of the key competences for ESD (Schneider, 2013). To develop empathy, for example, mindfulness exercises should be carried out in which care and responsibility towards other living beings are practised (Fritzsche et al., 2018).

ESD principles and ESD quality criteria provide important orientations for the planning and implementation of lessons. If design competence is initiated, an orientation towards didactic principles and quality criteria is central. These are both general didactic principles such as action and reflection orientation, accessibility and research-based learning, as well as ESD-specific principles such as networking learning, participation orientation and vision orientation (Künzli David, 2007, pp. 294-295). Teaching that considers the principle of networked learning is structured in a multi-perspective way and integrates different perspectives. At the same time, the interdependencies of local and global events as well as effects on future generations have to be considered. Participation orientation is understood as the involvement of students in the design of lessons as well as the examination of social participation (Keuler, 2019). Thus, ESD should take into account the young people's need to create and their tendency towards autonomy in order to strengthen a culture of sustainable development. In addition, the behaviour or the living environment of young people should be made the starting point of ESD (de Haan & Harenberg, 1999). Vision orientation describes the principle of developing common visions regarding sustainable development and their implementation in the classroom (Künzli David, 2007). The participatory approach, in which learners and teachers themselves identify, determine and develop relevant topics for sustainable education on an application-related basis, corresponds to the transformative claim of ESD in vocational education and training as well (Holst et al., 2020). However, this approach also creates challenges for cooperation within the science-practice cooperation if the practice-related

ideas for designing sustainability-oriented teaching/learning processes deviate from the scientific demands.

The Framework for Education for Sustainable Development lists six didactic principles, each of which is differentiated into key qualifications. The list by Künzli David (2007) is extended by the following principles: system and problem-solving orientation, communication and value-oriented learning, cooperation orientation and self-organisation. Classroom teaching that is system- and problem-solving-oriented promotes networked and future-oriented thinking and creativity. The principle of understanding and value orientation aims at being able to reflect and articulate one's interests. It includes the key qualifications of dialogue, self-reflection and conflict resolution skills as well as the competence to act in a value-oriented way. The principle of cooperation orientation is understood to mean the promotion of the ability to work in a team and a sense of community. The principle of self-organisation refers to the organisation and evaluation of learning processes (de Haan & Harenberg, 1999). Each of these principles is a necessary condition for the implementation of ESD, but not a sufficient condition on its own. They can only unfold their effect in the sense of ESD when they are combined.

Within the project ANU 2000 (n.d.), quality criteria for best practice examples of ESD were formulated. These are competence-oriented, they promote design competence and convey the key competences needed for this. Furthermore, they work with interactive and participatory methods that are suitable for teaching design competence. ESD is intended to enable people to shape the future with vision, imagination and creativity, to dare to try something new and to explore unknown paths. Accordingly, its methods are innovative and diverse. Participatory learning and participation in decision-making processes are central to sustainable development. Therefore, it is important to integrate participatory learning forms and methods into the lessons and to promote communication, cooperation, reflection and planning skills (de Haan & Harenberg, 1999). Further quality criteria are student and lifeworld orientation and experience and action orientation. Thus, best practice examples of ESD show real possibilities for action (Brundiers et al., 2010).

Learning is an active process that builds on previous knowledge, draws on a variety of sources, is a social process and requires motivation. Therefore, ESD learning situations should be designed that enable learners to learn actively in authentic, real-life environments (Schneider, 2013). Another important quality criterion is the selection of a key theme, such as consumption and lifestyle, global learning or global environmental risks (Brundiers & Wiek, 2013). ESD-relevant topics should concern a central local and/or global problem situation, be of long-term significance, be based on broad and differentiated knowledge about the topic and offer the greatest possible potential for action. Thus, generalisable knowledge should be gained by dealing with the topic. In

class, the selected topic should be examined from several perspectives (ecology, economy and social issues) (ANU 2000, n.d.).

Ecological, economic and social challenges must be considered together in every decision. This requires holistic thinking, inter- and transdisciplinarity. Multi-perspective learning means that, on the one hand, the subjective perspectives of the students and, on the other hand, the scientific perspectives of the topic are included. Following on from this, the next quality criterion demands that knowledge transfer and recommendations for action must be scientifically sound as far as possible. Open questions or contradictory views should also be presented as such. The following questions can be used for self-evaluation following the conception of a teaching unit (Bouverat, 2013):

- Does the lesson adequately address economic, social and environmental impacts?
- Are the students' previous experiences or knowledge considered?
- To what extent do the students reflect on the consequences for future generations?
- Are concrete possibilities for action shown?

The question of effectiveness addresses the extent to which a measure achieves (un)intended effects. The question about the mode of action is about the specific factors, processes and their interrelationships that lead to these effects. In order to examine the impact of teaching, it is necessary to outline impact pathways that explain how the individual components of teaching can contribute to changes in students' knowledge and behaviour (Scheffler, 2018). The relationship between people and the environment is a complex system and many influences interact, it is difficult to methodically attribute changes in students' behaviour to a single measure. An impact model can help to better understand central influences and interrelationships and plausibly justify results.

Fundamental assumptions and knowledge about 1) behaviour and its effects, 2) norms and values and 3) one's own possibilities of influence (self-efficacy) are important for sustainable behaviour (Bamberg et al., 2018). In the relevant literature, knowledge is understood as all content stored in long-term memory in the form of knowledge representations (Dornheim & Weinert, 2019). Factual knowledge, conceptual knowledge, procedural knowledge and metacognitive knowledge can be distinguished as different types of knowledge (Worbach et al., 2019). Conceptual knowledge as the knowledge about the relationships between facts is very significant especially in ESD topics because the challenges of today's globalised world are complex and depend on and are influenced by many factors. The acquisition of conceptual knowledge is an important basis for future action. Finally, students must be made aware that their (consumer) behaviour has consequences for society and that each individual can make an important contribution with his/her behaviour. Procedural knowledge, also referred to as action and method

knowledge, is particularly crucial for (future) environmentally conscious behaviour. For the measurement of the two constructs “conceptual and procedural knowledge”, there are a variety of different methods (Worbach et al., 2019). In measuring sustainable behaviour, a distinction can be made between the intention-oriented approach, which asks about self-reported, subjective behavioural intentions, and the impact-oriented approach, which measures actual environmental impact through behaviour (Scheffler, 2018).

Sustainable behaviour is understood as behaviour that is socially, environmentally and economically compatible. The recording of future sustainable behaviour is very complex, as it is influenced by many different factors. The psychological model for explaining sustainable behaviour is partly based on the theory of planned behaviour (Ajzen, 1991). This shows that a weighing process takes place before an individual acts. In this process, the costs and benefits of behaviour are weighed against each other to make a decision. The weighing process results in behavioural intention, although this is not automatically translated into behaviour. Finally, there are several influencing factors that can affect or prevent the desired behaviour (Hamann et al., 2016, p. 56). Thus, sustainable behaviour is influenced by a personal ecological norm, social norms as well as cost-benefit behaviour. At the level of the personal ecological norm, knowledge, self-efficacy, control, habits, experiences and alternative actions are significant influencing factors (Bamberg et al., 2018). Ajzen’s theory of planned action, therefore, does not alone provide the appropriate framework for behavioural prediction (Haddock & Maio, 2014). In educational research, indicators are used to capture ESD competences because future behaviours are latent constructs (Rieß et al., 2022).

Universities are important (educational) institutions where ecological, social and economic dimensions of society are considered in an integrated way. The aim is to develop solutions for current and future challenges and to train decision-makers for various fields of action (Bellina et al., 2020). Therefore, the curricular implementation of ESD in all study programmes is demanded (Molitor et al., 2023). In this way, it should be possible to make justifiable decisions despite unresolvable complexity and contradictions – also about pre-concepts and research-based knowledge (Pettig, 2021). Emancipatory reflection, decision-making and action skills for sustainably oriented design competence are aimed for.

The promotion of the necessary skills of knowledge acquisition, critical reflection, autonomous decision-making and action (Getzin & Singer-Brodowski, 2016) is also a task of teacher education. To implement ESD, teachers need sustainability-oriented design competence, which is based on subject knowledge, skills as well as sustainability knowledge, motivation and reflection of their own convictions. For teachers in the context of fashion and textiles, the question arises of how complex problem areas in subject

theory and subject practice can be developed in the sense of ESD to promote emancipatory design competence (Pettig, 2021).

Vocational education and training are seen as the key to the sustainable transformation of the professional world (de Haan et al., 2021). The aim of vocational education and training for sustainable development is to promote competences with which the working and living environment can be shaped in the sense of sustainability. In doing so, orienting professional action toward its ecological, social, and economic consequences is important (Hemkes et al., 2013). In general education, the focus is on patterns of consumption in the sense of a creative and skillful approach to textile material culture. ESD empowers teachers and students as consumers and professionals to contribute to sustainable development through civil society engagement and political action (Nachreiner et al., 2020). Besides the acquisition of knowledge, it is about the willingness to engage and to take responsibility, to manage risks and uncertainty, and the empathy for other people's circumstances and solid judgement on questions about the future.

The teaching and learning materials developed in the Fashion DIET project are linked to selected teaching units of the ESD module. They are suitable for the secondary level of the general education system and/or for the vocational education and training. Both theoretical and practical teaching sequences are presented. Due to the diversity of international curricula, there is no assignment to the educational systems. Teachers and trainers are encouraged to adapt the teaching units to the requirements of the learning group according to their own ideas.

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# 7 Take Home Message

JOCHEN STRÄHLE

Fashion sustainability is a topic that has gained increasing attention in recent years, as people become more aware of the fashion industry's negative impacts on the environment, workers, and local communities. The fashion industry is one of the most polluting industries in the world, with a significant carbon footprint and water usage. Moreover, fast fashion, which refers to the mass production of low-quality garments at cheap prices, is a major contributor to the industry's negative impact. Fast fashion promotes overconsumption and the disposal of clothes after just a few wears, creating a cycle of waste and pollution.

To make the fashion industry more sustainable, we need to focus on reducing waste, using sustainable materials, and promoting ethical labour practices. There are several ways to achieve this goal. For example, companies can adopt closed-loop systems, which involve recycling materials and reuse them in new garments. They can also use sustainable materials, such as organic cotton or recycled polyester, which have a lower environmental impact than conventional materials. Additionally, companies can promote ethical labour practices, such as fair wages, safe working conditions, and no child labour.

Consumers can make a big impact by choosing to buy from sustainable brands, investing in high-quality, long-lasting clothing, and recycling or donating old clothes instead of throwing them away. Buying from sustainable brands means supporting companies that prioritize sustainability and ethical practices, and who are committed to reducing waste and environmental impact. Investing in high-quality clothing means buying garments that are durable, timeless, and versatile, and that can be worn for years to come. Recycling or donating old clothes means reducing waste and giving new life to garments that would otherwise end up in landfills.

Fashion sustainability is not just an individual responsibility, but a systemic issue that requires collaboration between designers, manufacturers, retailers, and policymakers to create meaningful change. The fashion industry is complex and involves multiple stakeholders, each with their own roles and responsibilities. To create a more sustainable fashion industry, it is necessary to have a collaborative approach that involves all stakeholders working together towards a common goal.

While progress has been made in recent years, there is still a long way to go to make the fashion industry truly sustainable. It will take ongoing effort and commitment from all stakeholders to achieve this goal. This includes companies adopting sustainable practices, consumers making informed choices, and policymakers creating regulations

that promote sustainability and ethical practices. Ultimately, a sustainable fashion industry is not just good for the environment and workers, but for the industry itself, as it can lead to more efficient use of resources, better product quality, and increased consumer trust.

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# 9 Access to Databases

**Fashion DIET website** - Since the start of the project, the major project website continuously reports on the project's progress. The website represents the key access point to the information and e-learning platform. The website also offers access to further teaching and learning materials such as manuals, podcasts, and a supply of interactive and physical material. It thus ensures that the materials can be used in the classroom sustainably. Furthermore, the portal provides country-specific data for the fashion and textile industry and its market, taking into account the different university and school perspectives. The portal represents (1) the web-based platform to support the dissemination of ESD as a guiding principle and (2) a one-stop access point for the target group to gather relevant information about ESD.

Link to Fashion DIET website: https://fashiondiet.eu

**Glocal Campus** - The teaching and learning arrangements of the project are provided as Open Educational Resources on the open access e-learning platform Glocal Campus. Glocal Campus is a Moodle-based online platform that has transformed into an international university network enabling virtual cross-university exchange in a wide range of subjects.

Link to Glocal Campus: https://glocal-campus.org/login/altlogin/index.html

**Fashion + Textile Database** – This internet source is a comprehensive and systematic database for collecting current information on fashion and textile topics. The F+TD is the heart of any research approach within the International Fashion Retail Program and the place to find, create, and analyse data. Foci of the F+TD are usability studies of online shops, consumer behaviour surveys and analysis of communication concepts. Researchers will have the chance to conduct primary research with professional research tools. Furthermore, it serves as a research centre for the industry.

Link to F+TD: https://opus.bsz-bw.de/ftrc/home

# 10 Project Related Publications

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**Publications 2023**

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