PILOTING FASHION-TECH EDUCATIONAL STRATEGIES

PROOF OF CONCEPT FOR INNOVATIVE FASHION-TECH PRODUCTS AND SERVICES

edited by
Daria Casciani, Chiara Colombi

FTalliance

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Proof of Concept for Innovative Fashion-Tech products and Services

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DELIVERED

July 15, 2022

PUBLISHER

Politecnico di Milano

ISBN 9788894167443

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FTALLIANCE
Weaving Universities and Companies
to Co-create Fashion-Tech Future Talents

Erasmus+ KA2: Cooperation for innovation and the exchange of good practices - Knowledge Alliances
Call for Proposal: EAC/A03/2018
Acronym: FTall
Project Grant Agreement: 12662
Project Reference: 612662-EPP-1-2019-1-IT-EPPKA2-KA - FTall

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Co-funded by the Erasmus+ Programme of the European Union

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This publication is the result of a didactic research process involving students, teaching staff and industry experts from across Europe in three (3) learning experiences implemented over a period of almost one year (2021-2022). It aims to identify and describe the major lessons learned from the testing and piloting of three innovative Fashion-Tech learning experiences in order to discuss opportunities for Fashion-Tech (i) Strategic Innovation, (ii) applied Research for the future Education Agenda and (ii) cooperation, networking and partnership opportunities.

The work has been organised and synthesized by Politecnico di Milano as leader of the activities related to designing and piloting Fashion-Tech learning experiences (WP2), and project coordinator of the Fashion-Tech Alliance, a 3-years European academia-industries partnership project aimed to facilitate the exchange, flow of knowledge, and co-creation within the Fashion-Tech sector to boost students' employability and fashion-tech innovation potential. This project specifically involves five renowned Higher Educational Institutions Academic partners (Politecnico di Milano, Dipartimento di Design, ESTIA École Supérieure Des Technologies Industrielles Avancées, Högskolan i Borås, University of the Arts London - London College of Fashion, Technische Universiteit Delft), one Fashion-Tech research Centres (Centexbel) and seven industrial partners (Decathlon International, Pangaia Grado Zero, Pauline van Dongen, Pespow, Stentle / M-Cube Group, We Love You Communication, and PVH Europe). The aim of this project is to provide an evidence-based perspective on the Fashion-Tech education reporting on the relationship between advanced teaching/learning approaches about design, business management, and engineering that can be applied to the future generation of fashion-tech professionals.

This publication consists of five chapters presenting the learning experiences' workflow starting from the research premises, the implementation, and evaluation, followed by a reflection on the results with concluding remarks and future perspectives on Fashion-Tech education. Chapter 1 sets the premises of the Fashion-Tech educational research, meanwhile, the following chapters (2,3,4) present the case studies of the three piloted learning experiences describing the contents, objectives, and outcomes, reporting the methodology and lesson learned in terms of Fashion-Tech emerging topics, and reflections on the phases of the didactic experiences. Each of these chapters is followed by visual charts that present the results showcasing the portfolio of innovative Fashion-Tech concepts of products/services developed during the learning experiences. Finally, chapter 5 sets out the findings and future trajectories for Fashion-Tech education and collaboration. It discusses how the research findings led to setting the premises for prospective scenarios of the Fashion-Tech education, which serve as an invitation to open a collaborative discussion on the future of Fashion-Tech educational models, collaborative engagement between different stakeholders of the sector, and all concerned about the skills of future Fashion-Tech professionals.

This publication contains the deliverable D2.2 Proofs of Concept for innovative FT products/services, in fulfillment of the European Project FTalliance Weaving Universities and Companies to Co-create Fashion-Tech Future Talents (612662-EPP-1-2019-1-IT-EPPKA2-KA - FTall).

1. INTERPRETING THE FASHION-TECH PARADIGM IN DIDACTIC RESEARCH

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1.1 UNPACKING FASHION-TECH: DESIGN-DRIVEN PRODUCT, SERVICE AND PROCESS INNOVATION

The fashion sector, being both a socio-cultural and industrial system has been invested by the potentials of the "Forth Industrial Revolution" *(Schwab, 2016)*, conceived as the combination of emerging technologies such as electronics, and Information and Communication Technologies (ICTs) that allow the generation of cyber-physical systems (CPS) where physical, digital, and biological boundaries fade along the whole supply and value chain. The technologies at the base of the implementation of Industry 4.0 (I4.0) systems are the Internet of Things (IoT), Big Data and Artificial Intelligence (AI), advanced manufacturing (AM) and digital fabrication (DF), virtual reality (VR) augmented reality (AR), mixed reality (MR), and collaborative robotics (CR) *(Alcàcer & Cruz-Machado, 2019)*. These technologies are entering the fashion industry and enabling fashion brands to develop market intelligence strategies that endeavour to completely change fashion paradigms. The list of technologies further includes Radio Frequency Identification (RFID) & Near Field Communication (NFC) technologies, Blockchain, and Cryptocurrencies that show the potential to develop in the sector at a fast pace due to the digital transition and trackability for transparency.
In this context, Fashion-Tech has emerged and keeps growing as a pervasive, fragmented and transdisciplinary sector, missing a unanimous definition due to the complexity and transversality of the field. There are several different terms that address the phenomena, and approach it from multiple perspectives that provide different meanings and specifications. Few emerging scientific studies *(Bertola & Teunissen, 2018; Noris et al., 2021; Nobile, 2021)* and industry reports *(CB Insights, 2022; ETP, 2016)* have tried to provide a broad overview of the I4.0 implementations and development in the textile and apparel industry, with the aim of deeply anticipating the Fashion-Tech potentials and trends offering a clear framework on Fashion-Tech potentials and criticalities/limitations before its mainstream application. For example, the concept of "Fashion 4.0" has extended I4.0 in the fashion and textiles industry, defining a model of smart products, smart factories, and smart networks that affects fashion products, services, and processes toward innovation via decentralization, modularity, interoperability, real-time capabilities, virtualization and service orientation *(Bertola & Teunissen, 2018)*.
The concept of "Digital fashion" from Noris et al. *(2021)* and Nobile et al. *(2021)* attempts to develop a framework for the emerging sector through a taxonomic classification that reflects its interdisciplinarity complexity. Based on the adoption of ICTs in the fashion sector, the analysis frames the phenomena in three categories: (i) Communication and Marketing strategies in the digital era allowing the development of systems, methods, and models for shopping experiences and mediatization of communication; (ii) Design and Production focusing on automatization and digitalization of practices, processes, and tools involved in product, services and systems' implementation along with new business models and improved decision-making processes through effective and efficient structured workflows; (iii) Culture and Society with implications of digital fashion in terms of culture, education, and societal development.
ETP *(2016)* elaborates on the impact of the "fourth industrial revolution" on the European clothing and textile industry in relation to (i) digitisation of products, processes, factories, workplaces, supply chains, distribution, and retail, (ii) sustainability, circularity and resource efficiency of materials, processes and overall business operations and (iii) the proliferation of new business and consumption models based on sharing of productive resources and final products, servitisation, pay-per-use or subscription models. Therefore, the report conceives the future research topics on the fashion and textile industry impacted by technologies such as: (a) smart, high-performance materials, (b) advanced digitised manufacturing, value chains and business models, (c) circular economy, eco-innovation and resource efficiency, and (d) high-value-added solutions for attractive growth markets. For these four topics, it provides information of key collaboration partners for its successful development, the Technology Readiness Levels, and the expected time frame toward industrial deployment of technology.
An important aspect emerging from all these studies is the focus on sustainability and digitalization that together are expected to drive the parallel transition of the European fashion eco-system, increasing the application of a responsible approach to the technological innovation and promoting positive and more sustainable goals at the medium and long term *(Bertola and Vandi, 2021).* Being early positioned as the encounter of technologies, computer science and engineering and fashion, Fashion-Tech nowadays encompass social and behavioural sciences (e.g. psychology, sociology, anthropology, ethnology, economics, business and management), natural sciences (e.g. biology, chemistry), environmental science, addressing also specific sustainable challenges and constantly redefining its boundaries in this hybrid field of inquiry.
Considering this wide perspective that encompass bio-nano-info technologies and cognitive science, thus having an impact on society *(Roco et al., 2013),* the Fashion-tech paradigm could lead to open-innovation trajectories, both activating short terms opportunities and long-term effect, bringing the promise of deeply changing the industry, along with economies, and professionality's skills, thus impacting further the required educational models. At the same time, it raises ethical

implications and unpredictable impacts, widening the boundaries of the research. Therefore, a hybrid pedagogical approaches and the inclusion of transdisciplinary domains that pertains not only technological and engineering disciplines, but also social and natural sciences have the objective to shape future professionals able to navigate the complexity of new sustainable and societal challenges, changing the way people define their identities, make sense, live, produce and consume.

The innovation potential of Fashion-Tech can be activated by multidisciplinary, interdisciplinary, and transdisciplinary collaborative practices among different professionals of different disciplinary fields and professional backgrounds from industry, research centres, and training institutions, thus contributing to open knowledge in the sector toward a wider uptake, and application.

An important emphasis of the research is required for the development of a highly skilled and appropriately qualified workforce for the European future fashion, textile and clothing industry. EPT *(2016)* foresees an important generational shift in 2025 that should be accomplished by preserving specialized traditional skills and know-how and at the same time acquiring the current subject-specific skills that are deriving from the hybridization of the Fashion-Tech sector. In order to succeed, European Higher Educational Institutions (HEIs) and Vocational Education and Training (VET) institutions should support and further develop a world-leading Fashion-Tech education and training infrastructure in the widest sense and application. Therefore, it is important to boost didactic research about Fashion-Tech in terms of learning content and outcomes, pedagogy and learning environment, teaching methodologies and pedagogical practices, educational models and formats to be tested and piloted to inform new potential curricula for future-proof Fashion-Tech professionals. Digitalization, business innovation, sustainability, and societal impact / social challenges has been found to deeply affect the future profession in the Fashion-Tech sector.

Digitalization

Digitalization is defined as the adoption or increase in the use of digital technologies that affect the economy, society, and culture and enable a business transformation in operations, functions, models, processes, and activities *(Brennen and& Kreiss, 2016)*. Industrial digitalization involves structuring, shaping, and influencing a multidimensional transformation in the economic, societal, and cultural sense *(Brennen &and Kreiss, 2016)*. Digital transformation is associated with a wide alteration of value-creation paths that allow offering new products and services while managing the structural changes and barriers in the transformational process *(Vial, 2019)*. The European strategy toward

the digital transformation combines sustainability to guide the positive development of its industrial ecosystem toward a twin transition. In the aftermath of COVID-19 crisis, the European Commission has included resilience as an additional element toward the positive transition to include lesson learned from the crisis to re-establish a balance in a change-shifting global paradigm. The European efforts are also driven by a digital education agenda for the European citizens and professionals, whose scope is the achievement of universal digital skills, integrating all subjects and disciplines with computer science and information technology *(2030 Digital Compass: the European way for the Digital Decade, 2021; Digital Education Action Plan (2021-2027), 2021)* in the upcoming years.

Sustainability

Despite the United Nations has called HEIs to focus on education for sustainability in their higher education curricula, research activities, physical operations, and student lifestyle *(UNESCO, 2005)*, the indeterminacy of the term sustainability has challenged the real implementation of curricula towards the Education for Sustainable Development (ESD) *(DuPuis & Ball, 2013)*. Therefore, the adoption of the 2030 Agenda for Sustainable Development under the Sustainable Development Goals has provided a favourable environment to scale up the implementation of ESD, to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all”. Target 4.7 states that sustainability encompasses environmental preservation and includes sustainable human rights, gender equality, promotion of a culture of peace and nonviolence, and appreciation of cultural diversity *(UNESCO 2020)*. Thus, ESD in the Fashion-Tech sector aims to develop skills that enable and empower the future professional to reflect on their design actions, taking into account current and future social, cultural, economic and environmental impacts with local and global perspectives. In addition to provide contents on social, cultural, environmental and economic impact of the Fashion-Tech sector, ESD pushes toward interactive and learner-centred teaching and learning settings, toward a reflexive and action-oriented transformative pedagogy whose features are: self-directed learning, participation and collaboration, problem-orientation *(UNESCO 2018)*, to understand the “how” of sustainable Fashion-Tech practice, process, and design, while allowing the “what” of sustainability to emerge from interdisciplinary group interaction in a collaborative context.

Business Innovation

Even though, the digital technologies are in the early phase of commercialization, and existing research primarily explores the technological advancements allowed by its adoption *(Papachristou &and Bilalis, 2015; Spahiu et al., 2021)*, it is crucial exploring and gaining knowledge on new Fashion-Tech business models, revenue streams opportunities, and values creation, capture, and delivery within digitalization *(Parida et al. 2019)*. Digitalization determines structural changes at the front-end of business operations not only because of new products, but also because of the provision of services, that results in the transformation of the logic of business and value chain with new business models emerging from the co-creation with customers, the servitization, and the product monitoring/traceability. These new business opportunities and approaches require a shift and update of professional roles and skills inside the Fashion-Tech companies to support their sustainable and feasible development *(Chkanikova et al, 2021)*.

Societal impact / Social challenges

Technologies in fashion have particular impact on specific elements of society, since fashion is not just a material matter but also involves immaterial aspects mainly linked to culture, education and society. The different technologies that are changing the material fashion toward virtual one, as well as the communication technologies that enable connection, and mediatization are having a deep effect on how individual and communities shape their own identity through different social media channels. In addition to this, technologies in fashion can contribute to culture, education, and societal development *(Noris et al, 2021)*, addressing ethical aspects such as data management, privacy, safety, and surveillance linked to digital fashion and smart wearables, and configuring more inclusive and sustainable approaches in the fashion industry, in terms of awareness of sustainable consumption *(Collins, 2019)*, ethical behaviours *(Creangă, 2019)* and sustainable design and manufacturing processes.

1.2 EXPLORING DISCIPLINARY CONVERGENCES IN FASHION-TECH EDUCATION

ETP *(2016)* estimated that by 2025 the European fashion jobs market would face a generational turnover seeking for a qualified number of young professionals in the Fashion and Textile industry associated with the digitalization and emerging technologies across the operational, technical, managerial, creative and scientific sectors. To face the change, industry, higher educational institutions and research centres should strengthen their collaboration on accessing, delivering and developing scientific and advanced technological research and educational projects. It is important that future professional will be equipped with flexibility and multiple, transversal skills to face the paradigmatic shift of the Fashion-Tech industry toward digitalization of factories, and supply chain along with sustainability, and circularity, new business models and value-chain management.

The Fashion-Tech job is transformed in the convergence of skills between science, technologies, humanities and social sciences, reflecting the complexity and fluidity of modern reality where those areas are intertwined *(Carnevale et al., 2011)*. Convergent education allows knowledge to emerge beyond the borders of conventional academic disciplinary domains to fuse and integrate them toward a common interdisciplinary interest *(Casciani et al. 2021)*. The convergence of two or more disciplinary fields, majors, and subjects in education *(Nissan and Niroomand, 2006)* aims to cultivate future-proof talented professionals with enhanced specific disciplinary domain mindset and broader interdisciplinary knowledge that increases creative problem-solving abilities and responds to interdisciplinary labour demand *(Baek, Cho and Kim, 2019)*.

Convergence means widening disciplinary perspectives, empowering knowledge encounters, and integrating specialties with the purpose of generating new knowledge *(Hong, 2012)* to remain competitive in the work market and also to accomplish flexibility. In this rare savoir-fare, specialized expertise of traditional manufacturing and craft techniques, and unique design skills must be preserved through generational transfer allowed also using digital technologies and tools.

If the first discourse on convergence education emerged in the 70s at a seminar hosted by the OECD that classified it as multidisciplinary and interdisciplinary, Klein et al. *(2001)* also included the transdisciplinary category as a collaborative way of combining and redefining problems, it would contribute to incorporate concepts and knowledge across various fields. The Bologna Process in 2005 attempted to foster the adoption of convergence between European HEIs by establishing comparable

criteria and standards toward quality assurance in the European Higher Education Area, to achieve convergent educational curriculum, practices, and models at the organisational and instructional level.
In this context, the development of methodologies allowing the cooperation of students and professionals from different disciplines in the Fashion-Tech is based on systematic assignment division, collaborative problem-solving, critical reflexivity, experimental creative thinking, communicative and practice-based teaching/learning approaches to help the students dialogically converge toward one integrated product/service/system solution, and to produce intersubjective knowledge where disciplines from science, art, humanities, and technology entail a multi-perspective development.
The goal of Fashion-Tech convergent education is to allow students to get out from their disciplinary comfort zone to widen references and methodologies from others' disciplinary expertise, draw big pictures of the phenomena by linking different contexts, and explore the complexity equipped with a multidisciplinary vocabulary, and collaborative, participative interactive working modalities.
This tension toward transdisciplinary ways of knowing in the Fashion-tech sector should allow students from different background in humanities, social sciences, design, engineering and management to work on real-life problems through research methods allowing to acquire instrumental skills, to design new solutions that reflect the speed of the development of technology and lead new reflexive research with a systemic approach, including also sustainable implications in economic, environmental, societal and cultural terms.

1.3 DEFINING GUIDELINES AND APPROACHES OF A POSSIBLE CONTEMPORARY FASHION-TECH EDUCATIONAL MODEL

Considering the emerging crucial demand for the evolution of educational models towards the convergence of disciplinary fields and diffusion of new knowledge in the mutable sector of Fashion-Tech, the team of Politecnico di Milano, Dipartimento di Design in collaboration with the other HEIs involved in the FTalliance project has defined a series of guidelines and approaches for convergent education in order to test and pilot a proposed Fashion-Tech educational model. The teaching/learning method has been developed taking into account (i) the E4FT MA Fashion-Tech curriculum[1] *(Colombi and Teunissen, 2020)*; (ii) the recommendations taken during a cycle of three focus groups organised between HEIs, Fashion-Tech companies and research centres of the FTalliance consortium[2]; (iii) desk research about innovative pedagogical approaches such as Challenge-based learning *(Nichols and Cator, 2009; Nichols et al., 2016)*, Flipped Classroom *(Mazur, 2009; Berrett, 2012)*, and Social Learning *(Bandura, 1997)*. (Fig.1)

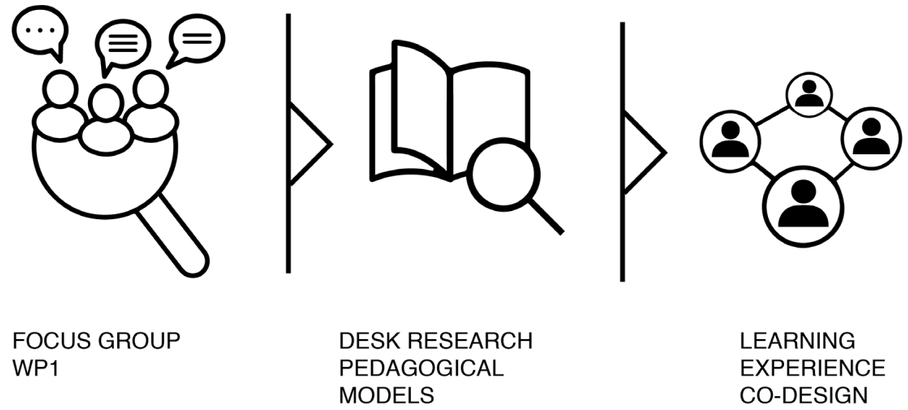

FIGURE 1 METHODOLOGICAL APPROACH TO DEFINE THE FORMAT/ EDUCATIONAL MODEL

The new integrated Fashion-Tech educational model would allow navigation and selection of the learning units to enhance the learning flexibility and personalization, advancing the learning modality from multidisciplinary to interdisciplinary and transdisciplinary. In addition to this, interactivity, participation, and direct companies' involvement was recommended to allow solving real-world problems and enable students to acquire instrumental skills and the development of critical and reflective thinking.

Three (3) pilot learning experiences[3] were planned and implemented within the FTalliance project duration to test the new educational principles and guidelines as follows[4] (Fig.2):

- **interaction and engagement** between different contents, sectors, disciplines, and HEIs and through both traditional (e.g. students learning from teaching staff) and non-traditional interactions (e.g. student learning from professionals and from peers in interdisciplinary teamwork project-based activities).
- **teamwork activities allowing learning from multidisciplinary to interdisciplinary and transdisciplinary** toward the "integration and modification of the disciplinary contribution" *(Stember, 1991)* allowed by more and deeper negotiations across the various disciplinary perspectives *(Choi & Pak, 2006)*.
- **personalized learning experiences** to address individual student's distinct learning needs, interests, aspirations, or cultural backgrounds, increasing students' level of choice as well as learning path responsibility.
- **learning flexibility** to accommodate differences of HEIs in organisational and instructional terms and to use subject-specific pedagogical techniques adequate for the Fashion-Tech areas across a variety of learning environments.
- **real world challenges** to achieve long-term retention of material, developing 'replicable' skills, and improving students' attitudes towards learning;

[1]The E4FT Fashion-Tech Curriculum, was developed as a two-year MA Fashion-Tech Design program with a modular and flexible structure. Divided into 3 Educational Sections of Focus (Design and Multimedia Communication, Technology and Engineering and Human Social, Psychological and Economic context) and consisting of 18 units in total, the MA program offered the option of levelled education for learners with a different background in education and experience. More information via this link: https://www.e4ft.eu/

[2]The integrated Fashion-tech Curriculum model is fully described in the D1.1 of the Fashion-Tech Alliance project available and fully downloadable at this link: https://fashiontechalliance.eu/images/reports-and-publications/D11_Integrated_industry_relevant_Fashion-Tech_Curriculum_Model_V3.pdf

[3]The learning experiences are conceived as cross-universities, international and interdisciplinary courses held digitally with a flexible timing and modular credits attribution, accounting for different academic calendars and structures. The asynchronous modules are delivered at the beginning of the course to share theoretical pillars as multidisciplinary contents for common knowledge and will last from 2 to 3 weeks, meanwhile, the synchronous challenge-based part will last from 6 to 8 weeks. Accordingly, the course will deliver from a minimum of 6 ECTS to a maximum of 7.5 ECTS, depending on each University.

[4]The educational model/format along with guidelines specifically applied to Fashion-Tech education are included in the D2.1 Project Based Learning Modules https://fashiontechalliance.eu/images/reports-and-publications/D2_1_Project_based_Learning_Modules.pdf

- **industry perspective inclusion and companies' involvement** in the definition and development of the courses.
- **open knowledge and accessibility of resources** provided by different entities, but also collected, curated toward the creation of a repository for the open digital literacy of students and professionals.
- **digital education approach**.

FIGURE 2 EDUCATIONAL MODEL GUIDELINES

Due to Covid-19 sanitary situation (2019-2022) and travel restrictions among European countries, the digital on-distance approach was mandatory to make the learning experience possible all around European HEIs (Politecnico di Milano - School of Design; ESTIA École Supérieure Des Technologies Industrielles Avancées; Högskolan I Borås; University of the Arts London - London College of Fashion; Technische Universiteit Delft) involved in the activities of the FTalliance project. However, the need to transform the educational experience into digital has been transformed into a teaching opportunity in order to test new collaborative digital tools, learning activities and outcomes developed at distance between learners and teachers.

The digitalization of education and the use of more interactive and collaborative components within higher educational e-learning is already a trend *(Richert et al., 2016)*. However the implementation of an effective e-learning system able to hybridize knowledge among multi-agent teams which are completely interconnected among themselves and their environment and allow interaction has to be still tested and understood in terms of learning outcomes and student engagement.

This aspect is central in the academic experience *(Tinto, 2006)* so

that it could result in student success, improved learning and better achievement *(Kahn, 2014; Zepke, 2014, Hoskins, 2012; Sinatra, Heddy, & Lombardi, 2015)*. Engagement is particularly important in distance and online educational contexts where dropout is a problem. In the FTAlliance learning experiences, engagement between learners-learners, and learners-educators was allowed through the use of several digital tools, such as discussion forums, chats, digital classrooms, and collaborative digital boards. The discussion forum is an essential tool to share and discuss assignments, exercises, and reflections among all participants (students, teachers, experts from companies), showing work and giving/receiving feedback. Collaborative digital boards (e.g. Miro, Mural, Conceptboard, Ziteboard, Whiteboard fox, Stormboard) allow students' to co-create a shared and meaningful body of knowledge, to interact, brainstorm, and to creatively co-design a product/service/system. The visual digital whiteboards are helpful as project management tools (i) in the phase of the learning experience preparation (from the interdisciplinary teaching staff and companies professionals) to converge and integrate different perspectives on teaching/learning activities as well as (ii) for students during the challenge-based part activities to control the workflow of activities, to map and visualize ideas in early creative stages, and as co-design tools, allowing groups to modify output and edit in real-time or asynchronously to facilitate transdisciplinary consensus buildings.

In organisational terms, the misalignment of calendars of each HEI has been arranged in order to allow students to participate to the learning experience with the least possible overlap with other courses of their study plan. To do so, an atypical calendar structure was structured to allow students with different backgrounds to participate and gain personalised learning experiences about the Fashion-Tech sector, with a synchronous and asynchronous modality.
The main structure is as follows (Fig. 3):

• a kick-off synchronous introductory lecture (WELCOME) aimed to welcome students, explain the learning experience by sharing the Syllabus

• a theoretical asynchronous part (DISCOVER) focusing on theoretical pillars conceived as contents, knowledge, and information in emergent subject areas of Fashion-Tech (e.g., concepts, theories, principles, methodologies, methods, and tools) about design, engineering, business management.

• An initial synchronous lecture (DEFINE) to brief the students with a challenge-based project delivered in collaboration with the companies involved in the learning experience;

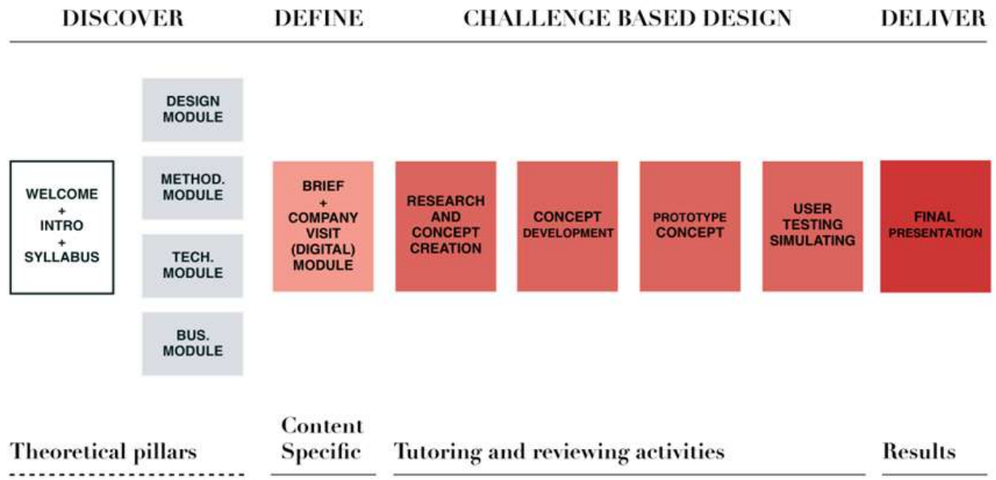

FIGURE 3 SCHEDULE OF THE LEARNING EXPERIENCES FROM WELCOME, DISCOVER, DEFINE, DESIGN AND DELIVER PHASES

• A synchronous challenge-based Learning-by-doing part (CHALLENGE-BASED DESIGN), where students from different disciplines approach a real-world challenge, while exploring and analysing the topic from their own subject specialism and discipline. Companies' contribute to the real-world challenge briefs, as well as through teaching and coaching activities co-implemented with teaching staff.

• A final synchronous delivery part (DELIVER) where students will be pitching their ideas and developed concepts toward an interdisciplinary committee made of teaching staff of different HEIs and professional experts from the Fashion-Tech companies

Each learning experience is expected to deliver:

• video lectures across different disciplines and subject-areas (e.g. design, engineering, and business management) that are released as Open Educational Resources (OERs) *(Miao, Mishra and McGreal, 2016).*
Each learning experience is expected to deliver:

• A portfolio of proof of concepts as learning outputs that do not focus on well finished Fashion-Tech end results but on proof of concepts and solutions with an emphasis on the process focusing on problematizing, reframing, and iterating in design, engineering, and

business management domains *(Cross, 2010)*.

As a result of the learning experiences, students are also expected to learn general soft-skills (e.g., communication, teamwork and interpersonal abilities, creativity and cooperation, serendipity, and an open and innovative mindset) as well as wide variety of Fashion-Tech Subject-specific skills *(Colombi and Casciani, 2021)* (Fig. 4).

FIGURE 4 - OVERVIEW OF THE SUBJECT-SPECIFIC SKILLS AS RESULTING FROM THE THREE FOCUS GROUPS AND INTEGRATED INTO THE THREE PILOT LEARNING EXPERIENCES OF THE FTALLIANCE (COLOMBI & CASCIANI, 2021)

1.4 PUBBLICATION'S OVERVIEW AND CONTENTS

This publication is the result of a didactic research process involving students, teaching staff and industry experts from across Europe in three (3) learning experiences implemented over a period of almost one year (2021-2022). It aims to identify and describe the major lesson learned from the testing and piloting of the three innovative Fashion-Tech learning experiences in order to discuss opportunities for the Fashion-Tech (i) Strategic Innovation, (ii) applied Research for the Education Agenda and (ii) cooperation, networking and partnership opportunities.

The work has been organised and synthesised by the Politecnico di Milano as leader of the activities related to designing and piloting Fashion-Tech learning experiences (WP2) and project coordinator of the Fashion-Tech Alliance, a 3-years European academia-industries partnership project aimed to facilitate the exchange, flow of knowledge, and co-creation within the Fashion-Tech sector to boost students' employability and fashion-tech innovation potential. Specifically, this project involves five renowned Higher Educational Institutions Academic partners (Politecnico di Milano, Dipartimento di Design, ESTIA École Supérieure Des Technologies Industrielles Avancées, Högskolan i Borås, University of the Arts London - London College of Fashion, Technische Universiteit Delft), one Fashion-Tech research Centres (Centexbel) and seven industrial partners (Decathlon International, Pangaia Grado Zero, Pauline van Dongen, Pespow, Stentle / M-Cube Group, We Love You Communication, and PVH Europe). The aim of this project is to provide an evidence-based perspective on the Fashion-Tech education reporting on the relationship between advanced teaching/learning approaches about design, business management, and engineering.

The publication consists of five chapters in which the didactic research is summarized presenting the research assumption, evaluation and implementation of case-studies as learning experiences in Fashion-Tech and results, conclusions and future perspectives.

Chapter 1 presents the premises of the Fashion-Tech educational research, aiming at unpacking the Fashion-Tech paradigm as a new, emergent and mutable sector for research and education to define new products, services and processes toward innovation and sustainability. This new domain is in need of new educational approaches to grasp the complexity of the sector and to implement new skills for the future Fashion-Tech professionals. For this reason, the chapter briefly covers the importance of convergence education in the Fashion-Tech sector as an introduction to define educational guidelines and approaches that were designed and implemented in three (3) learning experiences that involved teaching staff from five (5) European HEIs and nine (9) Fashion-

Tech professional experts, along with ninety-seven (97) interdisciplinary and international students.
The following chapters (2,3,4) present the case studies of the three piloted learning experiences describing the contents, objectives and outcomes, reporting the methodology and lesson learned in terms of Fashion-Tech emerging topics and reflections on the phases of the didactic experiences.
In particular, chapter 2 covers the learning experience about fashion digitalization and virtualization of the fashion processes that affect concept development and prototyping, production, supply chain operations, and business model innovation toward faster, smarter, more efficient and sustainable garments, products, and correlated services. Chapter 3 outlines the learning experiences focusing on Fashion-Tech value chains, aiming on identifying future sustainable development challenges to be solved by developing inter-disciplinary and scalable Fashion-Tech solutions from a social innovation perspective. Chapter 4 presents the learning experience about fashion wearable technologies, reflecting upon data ethics, and economic, environmental, and social sustainability through a process of research-informed design ideation.
Each of these chapters is followed by visual charts presenting the results of each learning experience collected in form of a portfolio of innovative Fashion-Tech concepts of products/services. Each concept is presented through its contents (e.g., short abstract, representative keywords, and visualizations) and interdisciplinarity of the team, the learning outcomes (e.g. soft and subject-specific skills) achieved by the students, and the learning experience process, highlighting the level of contribution and focus of the team in the different steps of the learning activity (e.g. research and inspiration, concept, development, prototyping, business model definition, and pitching) (Fig. 5), and the identified sustainability implications as the SDGs.

FIGURE 5 KEY DIAGRAM OF THE LEARNING EXPERIENCE PROCESS: ON THE LEFT SIDE THE PHASES DIVIDED BETWEEN RESEARCH AND INSPIRATION, CONCEPT, DEVELOPMENT, PROTOTYPING, BUSINESS MODEL DEFINITION AND PITCHING; ON THE RIGHT SIDE THE AMPLITUDE OF EFFORTS OF THE TEAM.

Finally, chapter 5 sets out the findings and future trajectories about Fashion-Tech education and collaboration, reflecting an encapsulated moment in time and challenges for Fashion-Tech educators and professionals, as well as students into Fashion-Tech studies. The provided lesson learned lead to set the premises for prospective scenarios of the Fashion-Tech education which serve as an invitation to open up a discussion on the future of Fashion-Tech educational models, collaborative engagement between different stakeholders of the sector, all concerned about the skills of future Fashion-Tech professionals.

REFERENCES

Alcácer, V., & Cruz-Machado, V. (2019). Scanning the industry 4.0: A literature review on technologies for manufacturing systems. Engineering science and technology, an international journal, 22(3), 899-919.

Baek, W., Cho, J. & Kim, Y. (2019). Convergence in school-to-work transition of engineering students: Korean evidence. Engineering Economics, 30(1).

Bandura, A. (1977). Social Learning Theory. New York: General Learning Press.
Berrett, D. (2012). How 'flipping' the classroom can improve the traditional lecture. The Chronicle of Higher Education, Feb. 19.

Bertola, P. & Teunissen, J. (2018). Fashion 4.0. Innovating fashion industry through digital transformation. Research Journal of Textile and Apparel, 22(4), pp.352-369.

Bertola P. & Vandi A. (2021). Fashion Design Education Towards Twin Transition. Developing multidisciplinary skills for future professionals. In Global Fashion Conference 2021. Poland Cracow ISBN: 978-989-54263-2-4

Brennen, J. S., & Kreiss, D. (2016). Digitalization and digitization. The International Encyclopedia of Communication Theory And Philosophy:1-11. doi:10.1002/9781118766804.wbiect111.

Carnevale, A. P., Smith, N., & Melton, M. (2011). STEM: Science technology engineering mathematics. Georgetown University Center on Education and the Workforce

Casciani D., Colombi C., Chae Y. & Kaspar J. (2021) Developing a Fashion-Tech Educational model. Hybridizing design, engineering, and business management education. Global Fashion Conference 2021, Warsaw, 21-22 October, 2021

CB Insights, (2022) The future of fashion: from design to merchandising, how tech is reshaping the industry." Available at: https://www.cbinsights.com/research/fashion-tech-future-trends/

Chkanikova O., Pal R., Gustafsson K. & Timour F. (2021). Shaping the future of fashion-tech - business models, roles and skills aiding digital transformations. Global Fashion Conference 2021, Warsaw, 21-22 October, 2021

Choi, B. C. K., & Pak, A. W. P. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. Clinical & Investigative Medicine, 29(6), 351–364.

Collins, R. (2019). Fashion acolytes or environmental saviours? When will young people have had "Enough"? In M. Ingleby & S. Randalls (Eds.), Just enough (pp. 99–115). Palgrave Macmillan UK. https://doi.org/10.1057/978-1-137-56210-4_7

Colombi C. & Casciani D. (2021) Fashion-Tech Alliance. Innovating professional digital competences and skills in the Fashion Industry.INTED2021 Proceedings, 2021. pp. 7842-7852 ISBN: 978-84-09-27666-0 ISSN: 2340-1079

Colombi C., & Teunissen J. (2020). Fashion-Tech Curriculum: a New Framework in Colombi C. and Tenuta L. (eds) Education for Fashion-Tech. Design and technology for future fashion creatives. Nielsen Book

Creangă, R. (2019). Fashion sustainability in the digital realm. In N. Kalbaska, T. Sádaba, F. Cominelli, & L. Cantoni (Eds.), Fashion communication in the digital age (pp. 198–208). Springer International Publishing. https://doi.org/10.1007/978-3-030-15436-3_18

Cross N. (2010), Designerly ways of knowing. London: Springer.

Digital Education Action Plan (2021-2027), 2021. Retrieved from [2 May 2023] at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0624&from=EN

DuPuis E. M. & Ball T. (2013) How not what: teaching sustainability as process, Sustainability: Science, Practice and Policy, 9:1, 64-75, DOI: 10.1080/15487733.2013.11908108

ETP (2016). Towards a 4th Industrial Revolution of Textiles and Clothing. A Strategic Innovation and Research Agenda for the European Textile and Clothing Industry (October 2016)

Hong, S. (2012). What is convergence: Reflect the future in the past of convergence. Science Books

Hoskins, B. J. (2012). Connections, Engagement, and Presence. The Journal of Continuing Higher Education, 60(1), 51-53. doi:10.1080/07377363.2012.650573.

Kahn, P. E. (2014). Theorising student engagement in higher education. British Educational Research Journal, 40(6), 1005-1018. doi: 10.1002/berj.3121

Klein, J. T., Grossenbacher-Mansuy, W., Häberli, R., Bill, A., Scholz, R. W., & Welti, M. (2001). Transdisciplinarity: joint problem solving among science, technology, and society: an effective way for managing complexity. Berlin: Springer.

Mazur E. (2009). Farewell, Lecture Science 323: 50-51.
Miao, F., Mishra, S. & McGreal, R. (2016). Open educational resources: policy, costs, transformation. Paris, UNESCO.

Nichols, M. H. & Cator, K. (2009), Challenge Based Learning White Paper. Cupertino, California: Apple, Inc.

Nichols, M. H., Cator, K., Torres, M. & Henderson, D. (2016) Challenge Based Learner User Guide. Redwood City, CA: Digital Promise.

Nissan, E., & Niroomand, F. (2006). Technological change and contribution to growth and convergence. Journal of Economic Development, 31(1), 113.

Noris, A., Nobile, T. H., Kalbaska, N., & Cantoni, L. (2021). "Digital fashion: A systematic literature review. A perspective on marketing and communication.", Journal of Global Fashion Marketing, Vol. 12 No. 1, pp. 32-46.

Nobile, T. H., Noris, A., Kalbaska, N., & Cantoni, L. (2021). "A review of digital fashion research: before and beyond communication and marketing.", International Journal of Fashion Design, Technology and Education, pp. 1-9

Papachristou, E. & Bilalis, N. (2015). "How to Integrate Recent Development in Technology with Digital Prototype Textile and Apparel Applications". Marmara University Journal of Science 27(3). doi:10.7240/mufbed.96632

Parida, V., Sjödin, D., & Reim, W. (2019). Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. Sustainability 11(391):1-18.

Richert A., Plumanns L., Gross K., Schuster K., & Jeschke S., (2016) Learning 4.0: Virtual Immersive Engineering Education, Digital Universities, International Best Practices and Applications, V.2 - N.2-3, p 52

Roco, M. C., et al. (2013). Convergence of knowledge, technology and society: Beyond convergence of nano-bio-info-cognitive technologies. Berlin, Springer

Schwab K., (2016) The fourth industrial revolution. World Economic Forum.

Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The Challenges of Defining and Measuring Student Engagement in Science. Educational Psychologist, 50(1), 1-13. doi: 10.1080/00461520.2014.1002924
Spahiu, T., Manavis, A., Kazlacheva, Z., de Amorim Almeida, H., & Kyratsi, P. (2021). Industry 4.0 for fashion products – Case studies using 3D technology. IOP Conference Series: Materials Science and Engineering 1031:012039 doi:10.1088/1757-899X/1031/1/012039

Stember, M. (1991). Advancing the social sciences through the interdisciplinary enterprise. The Social Science Journal, 28(1), 1–14. https://doi.org/10.1016/0362-3319(91)90040-B

Tinto, V. (2006). Research and practice of student retention: what next?. Journal of College Student Retention: Research, Theory & Practice, 8(1), 1-19.

2030 Digital Compass: the European way for the Digital Decade, 2021. Retrieved from [02 May 2022] at https://eufordigital.eu/wp-content/uploads/2021/03/2030-Digital-Compass-the-European-way-for-the-Digital-Decade.pdf

United Nations Educational, Social, and Cultural Organization (UNESCO), 2005. UNESCO and Sustainable Development. Paris: UNESCO.

United Nations Educational, Social, and Cultural Organization (UNESCO), 2020. Education for Sustainable Development: A Roadmap. Paris: UNESCO.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems 28(2):118-144. doi:10.1016/j.jsis.2019.01.003.

Zepke, N. (2014). Student engagement research in higher education: questioning an academic orthodoxy. Teaching in Higher Education, 19(6), 697-708. doi: 10.1080/13562517.2014.901956