FAIR FASHION

Championing Digital, Diverse & Sustainable Futures

STATE OF THE ART REVIEW

January 2025
State of the Art Review

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Co-funded by the European Union

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Expert Opinions

01 Prof. Dr. Ir. Troy Nachtigall

- Amsterdam University of Applied Science

The FAIR FASHION report provides important insights into gender dynamics in the fashion industry, reinforcing the need for continued research. Longitudinal studies are difficult to sustain, but they are necessary to track systemic changes over time. Inter-European cross-cultural comparisons and mapping of companies and professionals are critical to understanding how gender influences economic power and decision-making structures.
The report presents a clear paradox: while 98.5% of European fashion SMEs are reportedly female-owned, profitability and economic control remain predominantly male-driven. This highlights structural challenges that require deeper investigation. These gender dynamics are complex and not easily separated from broader industry trends.
This research is about more than identifying disparities; it must lay the groundwork for meaningful change. Connecting findings across different phases of study ensures that challenges are not just observed but also addressed. Moving forward, a structured and data-enabled approach will be key to fostering a more equitable and transparent industry.

02 Prof. Dr. Anne Schwarz-Pfeiffer

- Hochschule Niederrhein University of Applied Sciences, Department of Textile and Clothing Technology, Webschulstrasse 31, 41065 Moenchengladbach, Germany

This comprehensive review effectively synthesizes current research on digital transformation, sustainability, and gender perspectives in fashion education and entrepreneurship.

Key Strengths:
Strong theoretical foundation with extensive coverage of recent literature (2018-2025)
- Well-structured organisation with clear thematic sections
- Balanced integration of technological, social, and environmental perspectives
- Thorough examination of methodological approaches
- Effective use of case studies and practical examples
- Clear identification of research gaps and future directions

The review makes particularly important and valuable contributions in:
- Mapping the intersection of digital technologies and sustainability in fashion education
- Identifying barriers and opportunities for female entrepreneurs
- Highlighting the role of emotional and technical competencies in entrepreneurial success

This is a valuable contribution to the field that effectively synthesises current knowledge and identifies critical areas for future research. The review successfully balances academic rigor with practical relevance, making it useful for both researchers and practitioners in fashion education.

The document provides a solid foundation for understanding the complex interactions between digitalization, sustainability, and entrepreneurship in fashion education. It could serve as a key reference for educators and policy makers in the field.

Abstract

Fashion and entrepreneurship education are rapidly evolving to address the **challenges of digitalisation and sustainability in an interconnected world**.

This transformation introduces challenges such as resource constraints, gender inequities, and fragmented assessments.

Researchers have examined how digital technologies reshape education and entrepreneurship, particularly in circular and sustainable contexts.

Studies using qualitative, quantitative, and mixed-method approaches indicate that while innovations like AI, VR, and blockchain offer significant potential, their integration requires robust infrastructure and cross-disciplinary collaboration. Digitalisation is altering traditional methods, yet systemic gaps persist, especially in aligning sustainability goals with technological adoption. Bridging these gaps requires a coordinated approach that integrates digital advancements with sustainable practices.

Introduction

To achieve sustainability and innovation, fashion education and entrepreneurship are **integrating advanced technologies and environmentally conscious practices**.

To achieve sustainability and innovation, fashion education and entrepreneurship are integrating advanced technologies and environmentally conscious practices. This integration, though promising, creates tensions as stakeholders grapple with systemic barriers, including resource inequities and gender biases. Digital tools such as AI, VR, and blockchain are reshaping traditional approaches, but their effectiveness depends on overcoming these challenges.

Recent research investigates why digital technologies are pivotal to the evolution of sustainable practices, as well as how they redefine skill development and entrepreneurial success. Studies reveal a hierarchy of outcomes, where digital innovation often dominates over conventional pedagogical methods, yet struggles to align with sustainability metrics. Unexpectedly, emotional and behavioural competencies emerge as critical factors in addressing these gaps, underscoring the need for holistic education models. Resolving these tensions demands coordinated research and policy interventions, alongside a deep understanding of the interplay between technology and sustainability.

01

Circularity, Entrepreneurship, & Sustainability

The intersection of **digital technologies, circularity**, **entrepreneurship**, and **sustainability** is a dynamic and complex area of research.

Various studies have employed a diverse range of methodologies to explore these topics, each tailored to the specific objectives and context of the research Including examples and definitions of different research methodologies in the literature review provides clarity on how various approaches contribute to understanding complex relationships, helping to identify strengths, limitations, and applicability across different contexts in digitalisation, sustainability, and entrepreneurship research.

This section provides an overview of the methodologies utilised in recent studies and their contributions to understanding the multifaceted relationship between digitalisation, sustainability, and entrepreneurship. The methodologies identified include qualitative methods (such as case studies and semi-structured interviews), quantitative techniques (such as Structural Equation Modelling (SEM) and logistic regression), and mixed-methods approaches.

We examine **each methodology** in detail, illustrating how they have been applied in the research…

01 **Qualitative Methods:**
Case Studies and Semi-Structured Interviews

02 **Quantitative Methods:**
Structural Equation Modeling (SEM) and Logistic Regression

03 **Mixed-Methods Approaches:**
Combining Qualitative and Quantitative Data

04 **Systematic Literature Reviews:**
Synthesising Existing Research

05 **Implications and Conclusion**

01

Qualitative Methods:
Case Studies and Semi-Structured Interviews

Qualitative research methods have been crucial in exploring complex phenomena within digital entrepreneurship, sustainable practices, and circular business models. Case studies and semi-structured interviews were the most commonly employed techniques in several studies.

In the study by Perotti et al. (2023), an inductive case study approach was used to explore how digital technologies support small and medium-sized enterprises (SMEs) in adopting circular business practices. The researchers examined 16 SMEs across sectors such as manufacturing, chemicals, fashion, and food and beverage. Through semi-structured interviews with managers, the researchers gained in-depth insights into how digital tools, particularly Industry 4.0 technologies, facilitated the development of circular products and processes. This inductive approach allowed the researchers to identify common patterns and propose a generalisable framework for SMEs looking to transition to a circular economy.

Similarly, Rayna et al. (2021) study on fab labs and makerspaces employed semi-structured interviews with 13 fab lab founders and a focus group with founders and policymakers to examine how these spaces foster 21st-century skills. These interviews provided rich, context-specific data, revealing that while fab labs naturally support some entrepreneurial skills, explicit entrepreneurship programmes are needed to comprehensively nurture these abilities. This qualitative approach enabled the researchers to understand the nuances of skill development in these spaces and the role of digital tools in enhancing entrepreneurship.

Additionally, Mishra et al. (2023) conducted a qualitative interpretative study to assess how digital platforms empower female entrepreneurship in traditionally "pink-collar" industries like fashion and beauty. This research highlighted the role of digital platforms in transforming gendered industries by enabling women to overcome barriers and achieve entrepreneurial

Quantitative Methods:

Structural Equation Modelling (SEM) and Logistic Regression

02

Quantitative methods also play a significant role in analysing large datasets and testing hypothesised relationships. These techniques are particularly effective for uncovering generalisable patterns and validating theoretical constructs.

For example, in Wang et al. (2023) study on female digital entrepreneurs, Natural Language Processing (NLP) was applied to analyse data from 3,125 Kickstarter campaigns to understand the relationship between gender identity and crowdfunding success. The researchers found an inverted U-shaped relationship between displaying masculinity and crowdfunding success for female entrepreneurs, illustrating how digital platforms may replicate offline gender norms. This study demonstrated how quantitative techniques can offer insights into complex social dynamics in digital spaces.

In contrast, Baeza et al. (2021) used Structural Equation Modeling (SEM) to explore how factors such as education and self-efficacy affect entrepreneurial success in the digital space, specifically for female entrepreneurs. SEM allowed the among multiple variables, offering robust researchers to model and test complex relationships evidence for the ways that training and self-efficacy contribute to the entrepreneurial success of women in the digital realm.

Another study by Flagstad et al. (2022) utilised logistic regression to examine the role of personality traits, such as openness and conscientiousness, in driving social innovation among Polish micro-entrepreneurs. This quantitative approach helped validate the relationship between psychological factors and innovation outcomes, highlighting the significance of personality traits in entrepreneurial success.

Quantitative methods also include econometric analysis and survey techniques, which have been used to identify trends and test hypotheses within diverse industries. These approaches help quantify the impact of digital technologies and other variables on entrepreneurship and sustainability outcomes.

Mixed-Methods Approaches:

Combining Qualitative and Quantitative Data

03

Mixed-methods research combines both qualitative and quantitative data to provide a comprehensive understanding of the research topic. This approach enhances the validity and depth of findings by integrating insights from different sources.

An exemplary mixed-method approach was employed by Henninger et al. (2023) in their research on sustainable fashion management. The study combined theoretical frameworks with practical case studies to assess the integration of sustainability principles within fashion entrepreneurship. The combination of qualitative insights from industry case studies with quantitative data from sustainability metrics helped bridge academic theory and real-world applications, providing valuable insights for both researchers and practitioners in sustainable fashion management.

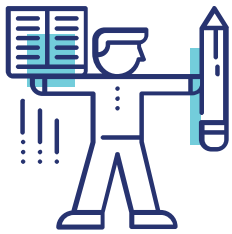
Similarly, Torres-Mancera et al. (2023) used a triangulated approach in their study on female sustainability and startups. The researchers combined in-depth interviews, digital content analysis,

and a literature review to analyse the leadership and communication strategies of female entrepreneurs in Spain and Portugal. This triangulation method allowed the researchers to cross-verify their findings from multiple data sources, ensuring a more comprehensive and accurate understanding of the challenges and opportunities faced by women entrepreneurs in sustainable business.

In addition, Sook Fern Yeo et al. (2022) merged quantitative surveys with semi-structured interviews to investigate AI's impact on fashion purchase decisions. This mixed-methods study helped capture both broad trends through surveys and in-depth insights through interviews, providing a nuanced understanding of the role of AI in consumer behaviour.

Systematic Literature Reviews:

Synthesising Existing Research



04

Systematic literature reviews are valuable for consolidating existing research and providing a comprehensive evidence base for further inquiry. This method is particularly effective for synthesising large amounts of research and identifying gaps in the literature.

For example, Abbasianchavari et al. (2020) conducted a systematic literature review on gendered education in entrepreneurship. By synthesising findings from 257 studies over nearly two decades, they provided valuable insights into how education influences entrepreneurial innovation, particularly in the context of gender.

This review clarified the relationship between educational experiences and entrepreneurial outcomes, offering a foundation for future research and policy recommendations in gender and entrepreneurship.

05 Implications and Conclusion

The research studies reviewed reveal a diverse range of methodologies, each chosen to best suit the research objectives and context. The use of qualitative methods like case studies and semi-structured interviews provided in-depth, context-specific insights into the dynamics of digital entrepreneurship, circularity, and sustainable practices. On the other hand, quantitative techniques like SEM, logistic regression, and NLP allowed for the analysis of large datasets and the testing of theoretical constructs. Mixed-methods approaches, including triangulation and the integration of qualitative and quantitative data, offered a more holistic view of the research topics.

These methodologies have contributed to a richer, more nuanced understanding of the complex relationships between digital technologies, sustainability, and entrepreneurship. As the field continues to evolve, future research should continue to leverage a variety of methodologies to deepen insights and provide guidance for policy development and practice. The combination of qualitative and quantitative techniques will be particularly valuable in addressing the multifaceted challenges and opportunities that arise at the intersection of these themes.

The growing trend towards data triangulation and technological integration in research methods, as seen in studies such as those by Zastempowski (2024) and Pereira (2024), underscores the increasing sophistication of research. This evolution highlights the potential for more integrated, comprehensive approaches to research in the future.

Key Takeaways

- **Digitalisation is transforming fashion and entrepreneurship education**, but systemic gaps persist in aligning technology with sustainability goals.
- **Cross-disciplinary collaboration and infrastructure** are essential for integrating AI, VR, and blockchain effectively.
- **Emotional and behavioural competencies** play a critical role in ensuring the success of digital and sustainable transitions.
- **A combination of qualitative, quantitative, and mixed-method research approaches** provides a comprehensive understanding of challenges and opportunities.
- **A coordinated and inclusive strategy** is needed to balance digital innovation with sustainability and equity in education and entrepreneurship.

02

Digital Technologies in Fashion Education

The landscape **of digital technologies in fashion education has transformed dramatically**, with research revealing several key technological implementations shaping modern educational frameworks.

Perotti et al. (2023) highlight how digital technologies are becoming essential in developing circular business models, while Rayna et al. (2021) document the crucial role of fab labs and makerspaces in fostering digital competencies aligned with EU frameworks. Current technology implementation shows a clear shift toward immersive and interactive platforms. Balsara et al. (2024) identify the growing adoption of VR/AR/MR solutions in fashion design education, particularly in areas like digital prototyping and virtual garment creation.

This trend is reinforced by Casciani et al. (2022) findings on how 3D virtual and digital technologies (3DVD) are revolutionising traditional design processes, enabling faster prototyping and more sustainable practice methods. Emerging technologies are reshaping the educational landscape in several key ways. Sook Fern Yeo et al. (2022) demonstrate how AI-powered technologies are transforming learning experiences, particularly in areas like trend analysis and design decision-making.

The integration of blockchain technology, as noted by Xin et al. (2025), is opening new possibilities in teaching sustainable fashion practices and digital fashion concepts within metaverse ecosystems. Additionally, George et al. (2021) emphasise how digital innovations are helping address sustainability challenges through advanced learning tools and simulations.

Integration of Digital Technologies in Fashion Education: Good Practice Examples

Fashion education is increasingly incorporating digital technologies to enhance learning experiences and prepare students for the evolving industry landscape. Several institutions have adopted innovative approaches, integrating Virtual Reality (VR), Augmented Reality (AR), blockchain, and Web3 technologies into their curricula.

These examples illustrate how **leading fashion institutions are leveraging digital tools to modernise education, foster innovation,** and **equip students with future-ready skills**.

01 Parsons School of Design (USA)

Has introduced VR and AR into its fashion programmes, offering students immersive learning opportunities. Through the XReality Center, students engage in workshops and projects that explore digital spatial narratives in AR. This initiative equips students with essential skills to navigate the digital fashion industry.
Bachelor of Fine Arts - Fashion Design XReality Center
Parsons and Roblox Partnership on Digital Fashion

02 Fashion Institute of Technology (FIT), USA

Has incorporated blockchain technology into its curriculum through courses like: "Introduction to Blockchain for Creative Businesses" (EP 362) – This course provides students with a foundational understanding of blockchain and its applications in creative industries. (Course description)

03 "The Future of Fashion: Web3, Metaverse, AI, AR & VR"

Explores Web3 applications in fashion, including blockchain and virtual experiences. (Course details)

04 "FM 331 - Technology and Transformation in Fashion Management"

Examines blockchain's role in fashion, including digital identities, IoT, and robotics. (Course description)

05 Instituto Europeo di Design (IED), Spain

Have integrated 3D tools into its Master's programme in Digital Fashion, enabling students to create virtual runways, digital fashion collections, and assets for video games. The programme covers the entire digital fashion creation process, from conceptualisation to user experience. (programme details)

06 Amsterdam Fashion Institute/AUAS, Program FASHION & DESIGN

Have developed skills in designing and translating sustainable and ethical fashion concepts into products and collections. Gained expertise in research, technical, creative, and commercial aspects, with a strong understanding of the fashion ecosystem and the designer's role within it. Acquired proficiency in digital and analogue craftsmanship, material construction, and communication, enabling seamless integration into professional environments.
Link https://amfi.nl/fashion-design/

Implementation challenges persist in the realm of digital engagement, as highlighted by *Mishra et al. (2023)* in their exploration of **'fempreneurship'** through digital platforms.

In their study, "Fempreneurship Through Digital Platforms: The 'Labyrinth Groove' and the 'Barricades' Within," they **analyse key barriers that parallel institutional challenges**:

01

Infrastructure and Resource Constraints:

Similar to the obstacles faced by women entrepreneurs, institutions struggle with inadequate digital infrastructure and limited financial resources. These shortcomings impede the seamless adoption of new technologies and hinder the potential for growth and innovation.

02

Digital Competency Gaps:

Just as women entrepreneurs encounter difficulties in acquiring the skills necessary to utilise digital platforms effectively, faculty members and institutional leaders also face a lack of training and digital proficiency. This gap prevents them from fully leveraging the benefits of technology. **Integration with Traditional Methods**: Women entrepreneurs often face challenges in aligning digital tools with societal structures and cultural expectations. Likewise, institutions experience difficulties in integrating digital innovations with established teaching methods and administrative practices, leading to fragmented and inconsistent implementation.

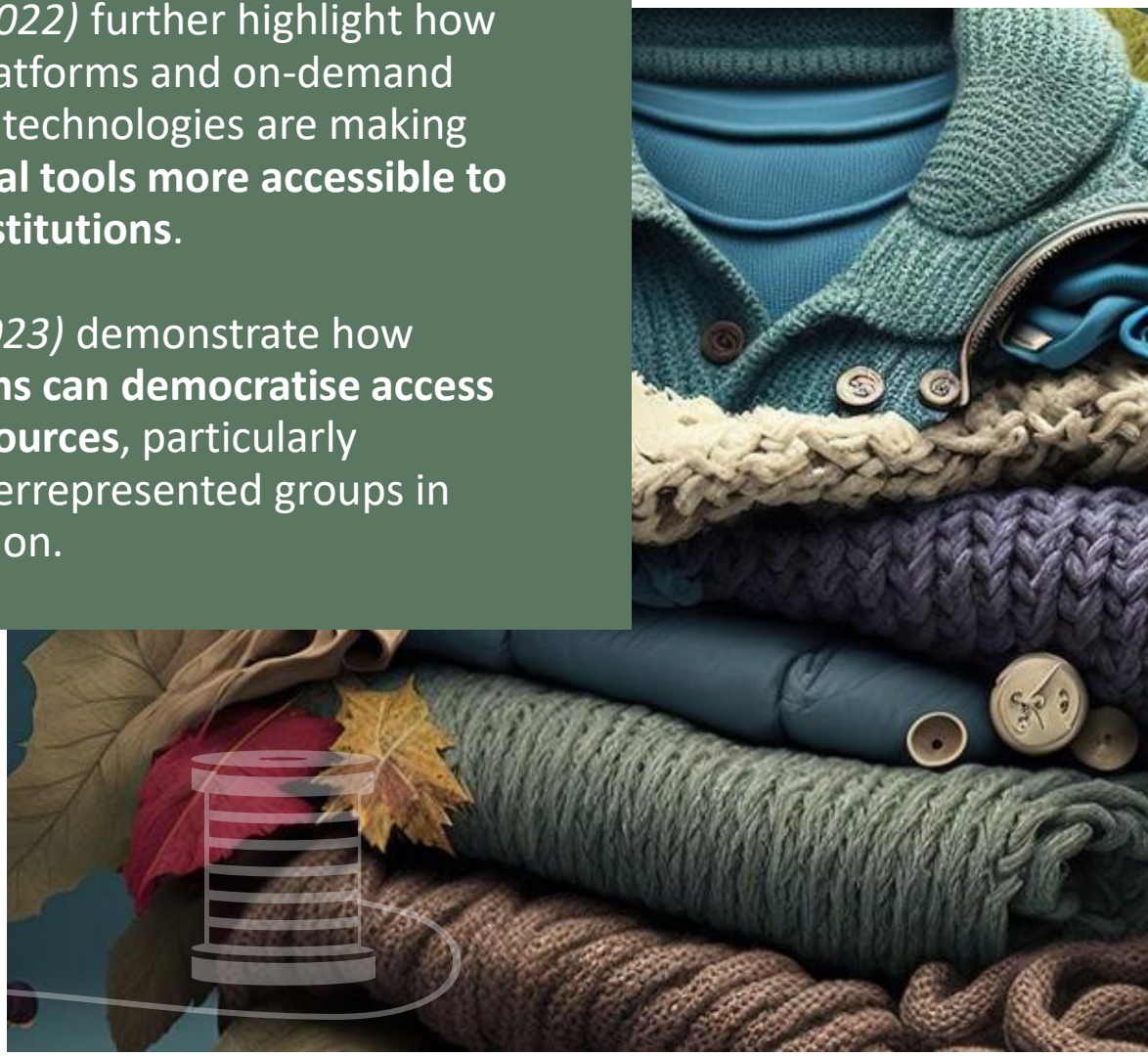
03

Resistance to Change:

Both fempreneurs and institutions encounter resistance to technological transformation. For women, this resistance is often rooted in societal biases and gendered expectations. Institutions, on the other hand, face reluctance due to skepticism, fear of change, or a lack of organisational support for new initiatives. By drawing these parallels, Mishra et al. emphasise the importance of addressing these systemic issues through targeted interventions. Key strategies include improving access to reliable digital infrastructure, implementing comprehensive training programmes, fostering an inclusive culture that supports innovation, and creating environments that encourage adaptation and collaboration. Such efforts are essential to achieving equitable and sustainable growth for both individuals and institutions within the digital ecosystem. Solutions emerging from recent research suggest practical approaches to these challenges. Martínez-Rodríguez et al. (2022), analysing 20 European countries, reveal that successful digital implementation depends heavily on government support and perceived institutional capabilities.

Their research suggests that targeted **policy interventions and capability-building programmes significantly improve technology adoption in fashion education**. *Akhtar et al. (2022)* further highlight how cloud-based platforms and on-demand manufacturing technologies are making **advanced digital tools more accessible to educational institutions**.

Wang et al. (2023) demonstrate how **digital platforms can democratise access to learning resources**, particularly benefiting underrepresented groups in fashion education.



The impact on learning outcomes has been significant and measurable. Jafari-Sadeghi et al. (2021) demonstrated that exposure to digital transformation tools enhances students' technological readiness and strengthens their innovation capabilities. This is supported by Henninger et al. (2023) findings that digital integration in sustainable fashion management education leads to enhanced student engagement and better practical skills development. The evolution of digital fashion education is particularly evident in new areas like metaverse-based learning. Xin et al. (2025) describe how virtual worlds offer opportunities for experimentation with digital clothing design, while reducing environmental impact through virtual prototyping. This shift toward digital-first education is creating what Sperber et al. (2022) term a "hybrid learning environment," where physical and digital skills development complement each other. These technological advancements are not just changing how fashion is taught but are fundamentally reshaping what skills are considered essential in fashion education. As Torres-Mancera et al. (2023) note, this digital transformation is creating new opportunities for innovation in teaching methods while simultaneously addressing sustainability concerns in fashion education.

03

Sustainability Integration

The **integration of sustainability in fashion education** has evolved significantly, reflecting industry demands and environmental imperatives. Recent research reveals **a comprehensive shift toward sustainable practices in educational frameworks**, with emphasis on both theoretical understanding and practical implementation.

Henninger et al. (2023) demonstrate how successful sustainable fashion management requires integration across multiple educational dimensions, from material selection to business strategy development. Current approaches to sustainability integration demonstrate three key trends. First, the study Opportunities and Conditions for the Development of Green Entrepreneurship in the Polish Textile Sector by Burzyńska et al. (2018) explores the potential for green entrepreneurship to drive sustainable practices in the Polish textile industry. Green entrepreneurship is presented as a business approach centred on environmentally sustainable practices, particularly critical in the textile sector due to its environmental impact.

The study highlights opportunities for sustainability, such as adopting eco-friendly materials, embracing circular economy principles like recycling, and leveraging technology for cleaner production. To foster green entrepreneurship, it emphasises the need for supportive policies, access to funding, and increased consumer demand for sustainable products. However, significant challenges remain, including the high cost of sustainable transitions, limited access to green technologies, and resistance to change within traditional industry structures (Burzyńska et al., 2018).

Since its foundation, the German company Hessnatur has focused on ecological and socially responsible production. It exclusively uses natural materials from controlled organic cultivation and ensures fair working conditions along the entire supply chain. In addition to implementing sustainable business practices, Hessnatur actively engages in various projects to promote sustainable textile production and operates as a foundation to further its mission (Wagner et al., 2016).

By showcasing examples and offering recommendations, such as fostering education, providing financial incentives, and promoting collaboration among stakeholders, the study underscores the potential of the Polish textile sector to align with global sustainability trends and balance economic growth with environmental responsibility (Burzyńska et al., 2018).

Second, Gasulla Tortajada et al. (2024) highlight the growing emphasis on luxury fashion's transition toward circular practices, influencing how sustainability is taught in high-end fashion programmes. Third, Makhloufi et al. (2021) show how green entrepreneurship orientation is becoming central to fashion education, particularly in developing environmental performance metrics. Assessment methods have become more sophisticated, with institutions adopting multi-faceted evaluation approaches. Torres-Mancera et al. (2023) outline several key assessment strategies:

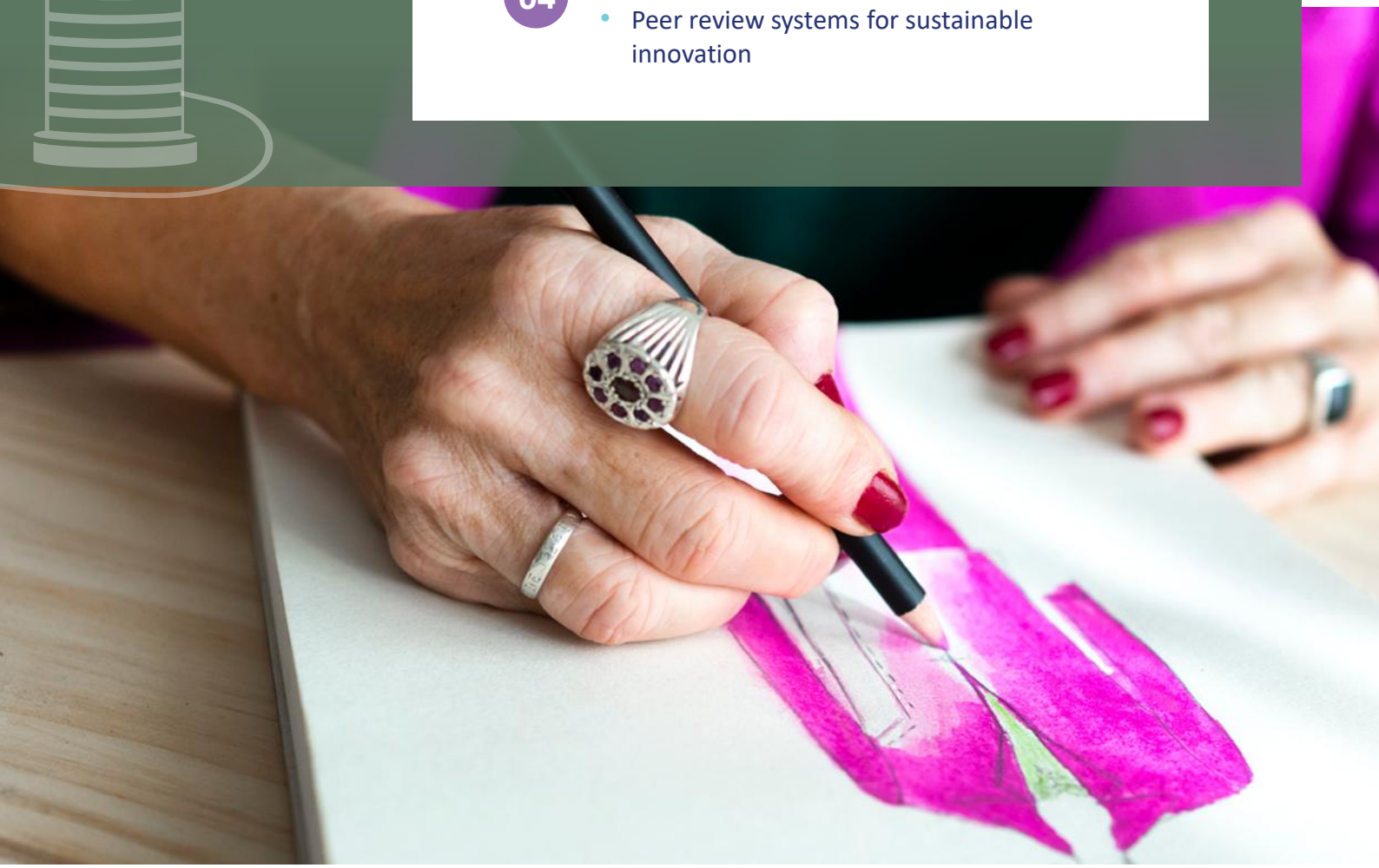
Torres-Mancera et al. (2023) outline several

01 • Portfolio-based evaluation of sustainable design projects

02 • Quantitative sustainability metrics tracking

03 • Industry-standard compliance assessments

04 • Peer review systems for sustainable innovation



These methods are strengthened by what Perotti et al. (2023) describe as "circular performance indicators," which measure students' ability to implement sustainable practices in real-world scenarios. Industry standards alignment has emerged as crucial for educational effectiveness. George et al. (2021) emphasise how digital sustainability activities must align with industry benchmarks to prepare students for professional practice.

This alignment includes:

01
- Environmental compliance standards

02
- Supply chain transparency protocols

03
- Ethical production guidelines

04
- Digital sustainability frameworks

The integration of circular economy principles represents perhaps the most significant shift in fashion education. Casciani et al. (2022) demonstrate how 3DVD technologies enable the dematerialisation of traditional garment production in education, promoting circular thinking from the design stage. Xin et al. (2025) further this concept by showing how metaverse ecosystems can promote sustainable digital fashion education while reducing physical resource consumption. Research by Rayna et al. (2021) reveals how fab labs and makerspaces serve as essential environments for experimenting with circular economy principles, providing students with hands-on experience in sustainable production methods. These spaces facilitate what Arcuri et al. (2023) term "innovation intensity," where sustainability and innovation intersect in educational practice. The successful integration of sustainability requires balancing technical skills with broader systemic understanding. Mishra et al. (2023) emphasise that effective sustainability education must address both practical competencies and theoretical frameworks, preparing students to navigate complex environmental challenges in the fashion industry.

This comprehensive approach ensures graduates are equipped to implement sustainable practices effectively while meeting evolving industry standards and requirements. This integration is further supported by what Zastempowski (2024) identifies as personality traits conducive to social innovation, suggesting that sustainability education must consider both technical and behavioural aspects of environmental responsibility. The research collectively indicates that successful sustainability integration in fashion education requires a balanced approach combining theoretical knowledge with practical application, digital innovation, and industry alignment.

Sustainability-Driven Consumer Behaviour in Luxury Fashion

Recent studies emphasise the growing importance of circular economy principles and sustainability in shaping consumer behaviour within the luxury fashion industry. Gasulla Tortajada et al. (2024) highlight how luxury brands are adopting practices such as recycling, upcycling, and transparent supply chains to reduce environmental impact while maintaining their exclusivity and appeal. These strategies not only support global sustainability goals but also align with the expectations of a rising segment of environmentally conscious consumers.

From this research, several **important lessons emerge:**

01 Consumer Behaviour as a Catalyst for Change

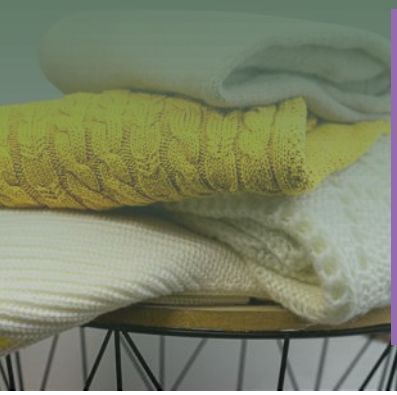
Consumers' increasing environmental awareness, sense of social responsibility, and desire for exclusive, yet sustainable products drive shifts in luxury fashion. However, barriers such as high costs, limited awareness, and skepticism around greenwashing remain significant challenges.

02 Circular Economy as a Transformational Approach

Circular economy practices—such as reusing materials, reducing waste, and implementing closed-loop systems—provide a roadmap for balancing sustainability with profitability. Luxury brands incorporating these methods, including garment rental and resale platforms, demonstrate how the sector can achieve both environmental and economic goals.

03 Education's Role in Promoting Sustainability

Empowering individuals through education is critical for fostering informed consumer behaviour. Raising awareness about sustainability, encouraging critical thinking about greenwashing, and offering hands-on engagement with circular economy principles can further drive sustainable change.



This research highlights the need to **integrate sustainability into education, fostering critical analysis and practical application to empower future generations** to advance circular economy initiatives and transform the luxury fashion industry.

04

Digital Entrepreneurship & Gender Perspectives

Digital entrepreneurship models in fashion education have evolved significantly, with research revealing **distinct patterns in how gender influences entrepreneurial success in digital spaces**.

Wang et al. (2023) discovered an intriguing paradox in their analysis of 3,125 Kickstarter campaigns: female entrepreneurs achieved better crowdfunding outcomes when presenting masculine traits, suggesting digital platforms may inadvertently reinforce traditional gender biases rather than eliminating them. In examining gender-specific challenges,

Their research **uncovered specific obstacles**: *Mishra et al. (2023)* identified what they term the "Labyrinth Groove" - a set of **unique barriers women face in digital entrepreneurship**.

01 • Digital platform accessibility issues

02 • Gender-based credibility challenges

03 • Resource acquisition barriers

04 • Work-life balance constraints

However, opportunities are emerging alongside these challenges. Arcuri et al. (2023) found that female-led firms actually use innovation more effectively for growth than their male-led counterparts, analysing over 4,600 Italian startups. This finding challenges traditional assumptions about gender and innovation capacity in entrepreneurship. Industry-academia collaboration has proven crucial in addressing gender gaps. Haddad et al. (2021) demonstrate through their study of 407 international business school students that diverse learning environments significantly enhance entrepreneurial intentions. Their research reveals that respect for diversity positively influences entrepreneurial attitudes and perceived behavioural co.ntrol, particularly among female students

This is further supported by Torres-Mancera et al. (2023), who outline successful collaboration models including:

01 • Industry-led workshops targeting women entrepreneurs

02 • Real-world project integration

03 • Professional mentorship programmes

04 • Joint research initiatives focusing on gender equity

The role of mentorship and support systems has emerged as particularly critical. Aly et al. (2021) emphasise how emotional skills development through mentorship significantly impacts entrepreneurial success.

Their research shows effective support systems should integrate:

01 • Leadership skill enhancement specific to women's needs

02 • Network building opportunities

03 • Industry-specific knowledge transfer

04 • Emotional intelligence development

Molina-López et al. (2021) further demonstrate how education helps women overcome digital economy barriers through structured learning pathways. Their SEM analysis reveals that targeted training programmes significantly improve women's self-efficacy in digital entrepreneurship. António Porfírio et al. (2023) highlight the importance of early intervention, showing how entrepreneurial intentions form during adolescence. Their research suggests that exposing young women to digital entrepreneurship early on can help break down gender barriers before they become entrenched. The findings collectively indicate that successful digital entrepreneurship requires a multifaceted approach that acknowledges and addresses gender-specific challenges while leveraging emerging opportunities. Sperber et al. (2022) demonstrate how gender bias in IT entrepreneurship creates self-reinforcing cycles that need to be actively countered through targeted support and education.

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Digital Entrepreneurship & Gender Perspectives

Research uncovered specific obstacles

- Digital platform accessibility issues
- Gender-based credibility challenges
- Resource acquisition barriers
- Work-life balance constraints
- Industry-led workshops targeting women entrepreneurs
- Real-world project integration
- Professional mentorship programmes
- Joint research initiatives focusing on gender equity
- Leadership skill enhancement specific to women's needs
- Network building opportunities
- Industry-specific knowledge transfer
- Emotional intelligence development

05

Technical Skills & Competency Development

The **evolution of technical skills in fashion education** reflects a dynamic **blend of traditional expertise and digital innovation**

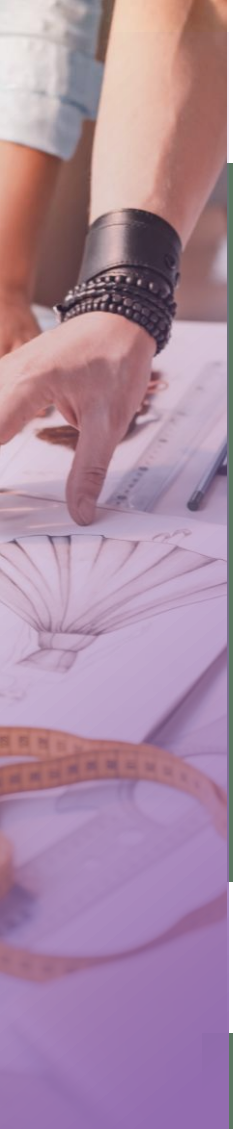
Rayna et al. (2021) explore the transformative potential of fab labs and makerspaces in fostering essential 21st-century skills in their study, "Fostering Skills for the 21st Century: The Role of fab Labs and Makerspaces". The authors emphasise the growing importance of skills such as creativity, critical thinking, collaboration, problem-solving, and digital literacy in an era defined by rapid technological advancements and shifting workplace demands. Fab labs and makerspaces, equipped with tools like 3D printers, laser cutters, and digital design software, serve as collaborative environments that promote hands-on learning and innovation. These spaces encourage a learning-by-doing approach, allowing participants to design, prototype, and create solutions for real-world challenges. Such experiential learning aligns closely with STEM education while fostering interdisciplinary collaboration (Rayna et al. 2021).

The study highlights the democratising potential of fab labs and makerspaces, which make advanced technological tools and knowledge accessible to a diverse audience, including students, entrepreneurs, and hobbyists. Additionally, these spaces act as community hubs that facilitate networking, collaboration, and knowledge-sharing among participants from various backgrounds.

Rayna et al. (2021) further discuss the implications for education and workforce development, noting that fab labs and makerspaces help bridge the gap between traditional curricula and the demands of the modern economy. By emphasising adaptability and technological proficiency, these environments prepare individuals for dynamic, innovation-driven work settings.

The authors also provide recommendations for policymakers and institutions to integrate fab labs and makerspaces into education systems and community development initiatives. Such integration can enhance access to these resources, promote innovation, and ensure broader societal impact. Overall, the study underscores the role of these spaces in equipping individuals with the skills needed to succeed in the 21st century while fostering inclusivity in technology and education.

Soft skills integration has become increasingly crucial, with Aly et al. (2021) highlighting the fundamental role of emotional and interpersonal capabilities in fashion industry success. Their research identifies critical soft skills including cross-cultural communication, adaptive thinking, and ethical decision-making. This is further supported by Henninger et al. (2023), who demonstrate how emotional intelligence complements technical abilities



Assessment frameworks have evolved to match this dual focus on technical and soft skills. *Perotti et al. (2023)* present evidence showing the **effectiveness of integrated assessment approaches that evaluate**:

01 • Practical technical abilities in digital environments

02 • Project management capabilities

03 • Innovation and creative problem-solving

04 • Professional communication effectiveness

05 • Sustainability awareness and implementation

Industry alignment emerges as a critical factor in skills development

Sook Fern Yeo et al. (2022) demonstrate how **AI-powered technologies are reshaping required competencies**, necessitating continuous updating of educational frameworks. *Wang et al. (2023)* further emphasise how industry-aligned competencies must include:

01 • Digital platform expertise

02 • Market analysis capabilities

03 • Innovation management skills

04 • Sustainable business practices

The research indicates that successful skills development requires a balanced approach combining technical proficiency with soft skills integration. Casciani et al. (2022) demonstrate how 3DVD technologies not only enhance technical capabilities but also foster collaborative and creative skills essential for industry success. This comprehensive approach to competency development ensures graduates are equipped with both the technical and interpersonal skills necessary for success in the rapidly evolving fashion industry

Innovation Intensity & Female-Led Firms

Arcuri et al. (2023) investigated the relationship between innovation intensity and the growth of female-led entrepreneurial firms, focusing on how innovation-driven activities influence business outcomes. The research highlights that innovation intensity—encompassing product development, technological advancements, process improvements, and business model innovation—plays a crucial role in driving growth metrics such as revenue, market expansion, and workforce development.

The study emphasises the distinct challenges faced by female entrepreneurs, including limited access to funding, professional networks, and resources. It demonstrates how innovation serves as a critical tool for overcoming these barriers, enabling female-led firms to remain competitive and achieve sustainable growth. Moreover, Arcuri et al. (2023) explore the variations in the impact of innovation intensity across different industries and cultural or regional contexts, revealing the unique dynamics that influence the growth trajectory of female-led enterprises.

Key findings also identify significant obstacles to innovation in female-led firms, such as financial constraints, societal biases, and unequal access to technology and skilled labor. To address these challenges, the study underscores the importance of building supportive ecosystems that include access to financing, mentorship opportunities, targeted training programmes, and robust professional networks. These elements are essential to enhancing the innovation capabilities of female entrepreneurs and fostering their long-term success.

This research provides actionable insights for policymakers, business leaders, and support organisations, illustrating how promoting innovation in female-led businesses can drive economic growth, support gender equity, and strengthen entrepreneurial ecosystems. By linking innovation intensity to measurable business success, the study highlights the transformative potential of innovation as a growth driver for female-led firms.

Emotional and Interpersonal Skills for Entrepreneurial Success

Aly et al. (2021) highlighted the role of emotional intelligence and interpersonal skills in driving entrepreneurial success. Their research underscores the necessity for education systems to incorporate emotional skills training alongside technical competencies, particularly for fostering resilience and adaptability in dynamic markets. This perspective aligns with emerging frameworks that emphasise holistic entrepreneurial education.

Technical Skills & Competency Development

- Practical technical abilities in digital environments
- Project management capabilities
- Innovation and creative problem-solving
- Professional communication effectiveness
- Sustainability awareness and implementation
- Digital platform expertise
- Market analysis capabilities
- Innovation management skills
- Sustainable business practices

06

Research Gaps & Future Directions

Fashion education and entrepreneurship are evolving fields influenced by advancements in digital technologies, sustainability integration, and an increasing focus on gender equity.

Recent studies have made significant contributions to understanding these domains, yet critical research gaps remain, offering avenues for future exploration.

This section discusses the **scientific contributions, identifies gaps in existing research, and proposes directions for future studies**.

Scientific Contributions

01 Advancements in Methodological Approaches

Research in fashion education has employed diverse methodologies to capture the complexity of the field. Quantitative approaches dominate, with sophisticated techniques like Structural Equation Modeling (SEM) used to explore the role of education in overcoming digital economy barriers for female entrepreneurs (Molina-López et al., 2021). Wang et al. (2023) applied Natural Language Processing (NLP) to analyse gender expressions in crowdfunding campaigns, while Arcuri et al. (2023) used panel data analysis to investigate the impact of innovation intensity on the growth of female-led firms.

Qualitative methods have provided depth in understanding complex phenomena. For instance, Torres-Mancera et al. (2023) employed a triangulated approach combining interviews and digital content analysis to study sustainability leadership. Mixed-methods approaches, such as those by Sook Fern Yeo et al. (2022), combine quantitative surveys with semi-structured interviews, offering comprehensive insights into AI's impact on consumer behaviour. These methodological advancements reflect increasing sophistication in research practices and the integration of technological tools (Zastempowski, 2024).

02 Integration of Sustainability in Fashion Education

Sustainability has become central to fashion education. Henninger et al. (2023) demonstrated the importance of embedding sustainability across curricula, from material selection to strategic planning. Studies like Burzyńska et al. (2018) highlight the potential of green entrepreneurship and circular economy principles, such as recycling and cleaner production technologies, to drive sustainable practices. Digital tools, including blockchain and 3DVD technologies, are transforming traditional teaching methods by enabling sustainable virtual prototyping and metaverse-based learning (Casciani et al., 2022; Xin et al., 2025).

03 Advancing Gender Equity in Digital Entrepreneurship

Studies have also examined gender-specific challenges and opportunities in digital entrepreneurship. Mishra et al. (2023) explored barriers such as resource acquisition and work-life balance, while Arcuri et al. (2023) revealed that female-led firms often leverage innovation more effectively than male-led ones. These findings offer critical insights into fostering gender equity in entrepreneurial ecosystems.

04 Development of Essential Skills for the 21st Century

fab labs and makerspaces have emerged as critical environments for skill development. Rayna et al. (2021) emphasised their role in fostering creativity, problem-solving, and digital literacy, aligning with STEM education goals.

Research Gaps

Despite these advancements, significant gaps persist in the literature:

01 Limited Longitudinal Studies

Henninger et al. (2023) highlighted the lack of longitudinal studies tracking the long-term impacts of educational innovations, particularly in understanding the sustained outcomes of digital transformation and sustainability integration.

02 Insufficient Cross-Cultural Perspectives

Comparative analyses of how cultural and regional contexts influence fashion education and entrepreneurial outcomes are limited. Pereira (2024) identified the need for cross-cultural research to capture the diverse realities of learners and entrepreneurs worldwide

03 Emerging Technology Integration

While research on VR, AR, and metaverse ecosystems in education is growing, gaps remain in understanding their environmental and pedagogical implications. Balsara et al. (2024) and Xin et al. (2025) both pointed to the limited exploration of these technologies in educational settings.

04 Lack of Standardised Assessment Frameworks

Perotti et al. (2023) highlighted the need for comprehensive tools to evaluate digital competencies and sustainability integration. Current assessment methods are inconsistent, limiting the ability to measure educational outcomes effectively.

04 Intersection of Sustainability and Digital Transformation

Research exploring how sustainability and digital transformation intersect is scarce. Mishra et al. (2023) noted that these two areas are often studied in isolation, despite their potential to drive systemic innovation.

Future Research Directions

Addressing these gaps requires targeted and coordinated efforts across academia and industry:

01 Development of Standardised Tools

Future research should prioritise creating comprehensive frameworks for assessing digital and sustainability competencies. These tools would enable consistent measurement and comparison across institutions (Perotti et al., 2023).

02 Longitudinal Impact Studies

Long-term studies are essential to track the sustained impacts of educational innovations. This research would provide insights into how digital technologies and sustainability practices influence career success and entrepreneurial outcomes (Henninger et al., 2023).

03 Cross-Cultural Comparative Analyses

Expanding cross-cultural research can enrich understanding of how diverse contexts shape educational frameworks and entrepreneurial practices. Such studies would identify universal strategies and region-specific challenges (Pereira, 2024).

04 Integration of Emerging Technologies

Further investigation into VR, AR, and metaverse-based learning platforms is necessary to evaluate their effectiveness and environmental impact. This research could identify best practices for integrating these technologies into fashion education (Balsara et al. 2024; Xin et al., 2025).

05 Exploration of Intersectionality

Future studies should examine the combined impact of sustainability and digital transformation. Research in this area could uncover synergies that foster innovation and address systemic challenges in education and entrepreneurship (Mishra et al., 2023).

06 Policy and Ecosystem Development

Research on the role of policies and industry-academia collaborations can guide efforts to enhance digital engagement, gender equity, and sustainability practices. These studies could identify strategies to build supportive ecosystems for learners and entrepreneurs (Martínez-Rodríguez et al., 2022).

07 Behavioural and Emotional Competencies

Investigating the integration of emotional intelligence and adaptive skills into educational frameworks is critical. This research could explore how these competencies complement technical skills to enhance entrepreneurial success (Aly et al., 2021).

07

Conclusion

The integration of **digitalisation and sustainability in fashion** and **entrepreneurship education** presents both **opportunities and challenges**.

While technologies such as AI, VR, and blockchain have the potential to transform education and business models, their implementation requires robust infrastructure, cross-disciplinary collaboration, and policy support. The research reviewed highlights how digital tools can democratise access to learning, enhance skill development, and foster innovation, but also underscores persistent systemic gaps, such as resource constraints, gender inequities, and the misalignment of sustainability goals with technological advancements.

Methodologically, studies have employed qualitative, quantitative, and mixed-method approaches to examine these complexities, providing insights into digital transformation, sustainable practices, and entrepreneurial success. Best practice examples, such as fashion institutions integrating digital tools and companies like Hessnatur prioritising sustainability, demonstrate the real-world impact of these innovations. However, institutional barriers, digital competency gaps, and resistance to change remain critical challenges, necessitating targeted interventions in education and policy.

Moving forward, a coordinated and inclusive strategy is essential to bridge the divide between digital innovation and sustainability. Future research should focus on developing standardised assessment frameworks, conducting longitudinal studies, and exploring the intersection of sustainability and digitalisation. Expanding cross-cultural research, integrating emerging technologies, and addressing behavioural and emotional competencies will be key to shaping equitable and future-ready educational ecosystems. By addressing these gaps, fashion and entrepreneurship education can evolve into more sustainable, inclusive, and technologically advanced domains, preparing students and entrepreneurs for a rapidly transforming industry. .

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