Fecha de recepción: marzo 2026
Fecha de aceptación: mayo 2026

Design-Based Research for Education in Regenerative Textile Bioeconomy: A Case Study of Be@t Schools

Raquel Santos, Teresa Luísa Silva y Carla Joana Silva[1]

Abstract: This paper presents a design-led research case study developed within the be@t - Bioeconomy at Textiles project, through an awareness-raising schools programme spanning primary, secondary, and higher education in Northern Portugal, a region where the textile and apparel industry represents a historically and economically significant socio-technical ecosystem. Positioned within the debates on design beyond sustainability, regenerative design, and regenerative economies, the study argues that educational settings can function as early-stage infrastructures for systemic change by shaping capacities, values, and local relationships that support regenerative textile bioeconomy pathways. In this paper, "regenerative textile bioeconomy education" refers to educational approaches that introduce circular bioeconomy and regenerative design principles in textile contexts, supporting systems thinking about materials, value chains, and end-of-life options in relation to local socio-economic and environmental realities. Grounded in an ethnographic informed perspective and a research-through-design framework, the study investigates how participatory, practice-based methodologies enable learners to develop systemic, critical, and future-oriented understandings of textile production, waste, and circular bioeconomy principles. The programme engaged learners as active change agents through hands-on activities such as guided school-based mapping of textile waste and practices, material exploration with biomaterials, mapping of local textile ecosystems, and collaborative workshops involving, where feasible, external stakeholders. Co-creation workshops brought together students, teachers, higher education facilitators, and industry partners to prototype educational materials and small-scale awareness actions, embedding iterative reflection, learning by doing, and speculative exploration of regenerative textile futures. A qualitative reading of the materials suggests shifts in how learners and educators articulated textile-system challenges, including greater attention to social, environmental, and economic dimensions and more frequent use of systemic and future-oriented language. No quantitative assessment was conducted; reported outcomes are therefore limited to practice-based insights and observed or self-reported reflections during and immediately after activities. The paper discusses the value and limitations of this design-led approach for connecting education, research, and community practice, and outlines a methodological model intended to be adaptable to other contexts, subject to local resources and partnerships.

Keywords: Research-through-design - textile bioeconomy - textile waste - regenerative design - circular bioeconomy education - awareness-raising - social innovation

[Resúmenes en español y portugués en la página 44]

---

(1) Ver CV en pág. 45

Introduction

Textiles have become a strategic sustainability domain. In the European Union, the consumption of clothing, footwear, and household textiles reached 19 kg per person in 2022 and ranked among the top household consumption categories in terms of environmental and climate pressures. In the same year, EU Member States generated about 6.94 million tonnes of textile waste, equivalent to 16 kg per person, while the separate capture rate remained below 15%, highlighting the structural gap between consumption, disposal, and circular recovery. (European Environment Agency, 2025)

This challenge is particularly relevant in Northern Portugal, where the textile and apparel sector remains a historically rooted and economically significant socio-technical ecosystem. Portugal's textile and clothing industry was the fifth largest in Europe by revenue in 2021, accounting for 18% of both companies and employees in national manufacturing. The sector is strongly concentrated in the North, with Porto and Braga together representing 82% of all textile companies and 85% of total turnover (AICEP Portugal Global, 2024)

At the same time, the identity of the Portuguese textile sector is changing. While the industry has long been associated with traditional, labour-intensive production and cost-based competitiveness, recent studies describe a significant shift toward innovation, technical specialisation, quality, and sustainable production (Moreira, L et al, 2023), (Ribeiro, V. M., & Soares, I., 2024). This transition also implies new skill requirements. European industrial-ecosystem analyses show a mismatch between education and sectoral needs, with persistent green and digital skills gaps in textiles. (Izsak, K., & Moreno, C. 2024).

These changes raise an educational question. In Portugal, environmental education already includes themes such as waste, responsible consumption and circular economy across school levels (Câmara, A. et al 2018).. However, these themes are addressed generically, leaving room for textile-specific educational approaches, particularly in regions where textile production, consumption, labour, and innovation are locally significant.

Within this context, the be@t - Bioeconomy at Textiles project offered a setting in which teachers, educators, trainers, and higher education actors identified the need for educational action focused on textile systems, waste and bioeconomy transitions. Although a school's programme was not originally central to the project structure, this need led to its emergence as a design-led response (CITEVE, 2025).

This paper examines that process and argues that schools and local learning ecosystems can function as early infrastructures for regenerative textile bioeconomy transitions. Methodologically, the paper adopts an ethnographically informed, research-through-design perspective to analyse how such an educational response was framed, developed, and enacted.

1. Textile sector transition

The textile and apparel sector is undergoing a structural transition that is simultaneously environmental, technological, economic, and cultural. At European level, textiles remain a high-impact consumption domain, while circularity indicators continue to reveal a significant gap between consumption, disposal, separate collection, and effective recovery. In Portugal, this challenge has particular relevance because the textile and clothing industry remains one of the country's most important manufacturing sectors and is strongly concentrated in Northern Portugal, especially in the districts of Porto and Braga (European Environment Agency, 2025) , (AICEP Portugal Global, 2024),

At the same time, the Portuguese textile sector can no longer be understood only through the lens of traditional low-cost production. Recent literature points to a reconfiguration of the sector toward innovation, quality, technical specialisation, export orientation, and the adoption of greener technologies and more sustainable practices (Moreira, L., et al 2023) (Ribeiro, V. M., & Soares, I. 2024). Internal competitiveness and market leadership in the adoption of green technologies in the Portuguese textiles and apparel industry. Sustainable Energy Technologies and Assessments, 69, Article 103899. This transition is not only changing products and processes; it is also reshaping the knowledge base, competences, and public narratives associated with the sector. These transformations raise an important educational and territorial question. If the textile sector is changing, the social understanding of what textiles are, who works in the sector, and what futures it can support must also change. This is particularly relevant in regions where textile production is not an abstract industrial category but part of everyday life, local memory, and regional identity. In this sense, the transition of the textile sector cannot be framed only as an industrial modernization process. It also requires a cultural transition capable of reconnecting industry, territory, education, and society.

The urgency of this educational dimension is reinforced by the European diagnosis of green and digital skills gaps in the textile ecosystem. (Izsak, K., & Moreno, C., 2024). In other words, the transition of the sector depends not only on new technologies and materials, but also on the formation of new ways of understanding textile systems, their environmental implications, and their future development pathways.

2. Awareness-raising and local context

In the Vale do Ave and the wider textile region of Northern Portugal, textiles are deeply embedded in the historical formation of the territory. The region's industrial trajectory emerged from earlier flax traditions and evolved into a dense textile landscape in which factories, homes, family labour, technical know-how, and local entrepreneurship became closely intertwined.[6,11] This long-standing relationship helps explain why textiles remain economically important and territorially visible. However, the local relationship with the textile sector is not straightforward. Within the contextual inquiry developed for the be@t Schools programme, teachers, educators, and facilitators repeatedly identified a form of social ambivalence toward textiles. On the one hand, the territory retains strong productive know-how, export capacity, and industrial relevance. On the other, textile work is still frequently associated, in public imaginaries and family narratives, with an older model of labour characterized by low wages, hard work, and limited social recognition (Internal project documentation). In parallel, regional studies on Vale do Ave continue to identify challenges affecting young people, including skills mismatches, unemployment, and precarious work, which shape how industrial futures are perceived. (Barroso-Hurtado, D., et al, 2022).

This ambivalence is central to the rationale of the programme. In a territory with deep manufacturing know-how, awareness-raising cannot be reduced to generic environmental messaging about waste or recycling. It must also address the cultural distance that has emerged between society and the textile sector itself. In this sense, awareness-raising becomes a dual task: to improve literacy about textile impacts and circularity, and to help re-signify the sector as a space of innovation, transformation, and future-oriented professional and civic engagement. Such an approach is particularly relevant in the context of bioeconomy transition. As the sector moves toward bio-based resources, circular systems, traceability, ecodesign, and more responsible production and consumption models, it must also attract new generations of learners, workers, designers, engineers, and informed consumers. Educational settings therefore become important mediating spaces where students can engage with local realities while also understanding the planetary consequences of textile production, use, and disposal.[7]

Awareness-raising, in this framework, is not conceived as a one-directional transfer of information. Rather, it is understood as a situated and participatory process through which learners relate local industry, everyday consumption, environmental consequences, and future imaginaries. Schools are especially relevant here because they can connect household practices, territorial identity, and industrial transition at an early stage, before fixed perceptions and professional choices become more stabilised.

3. Regenerative textile bioeconomy education

Within this paper, regenerative textile bioeconomy education is understood as an educational approach that goes beyond generic sustainability awareness and beyond narrow conceptions of recycling education. It refers to pedagogical practices that introduce learners

to circular bioeconomy and regenerative design principles through textile-specific, place-based, and systems-oriented inquiry.[6,9] This perspective differs from approaches centred only on minimizing damage or promoting isolated "good behaviours". A regenerative perspective invites learners to understand textiles as part of broader living, material, social, and economic systems, and to question how those systems might be redesigned to support restoration, circularity, responsibility, and long-term viability. In educational terms, this implies developing capacities for systems thinking, material literacy, critical reflection, collaborative imagination, and future-oriented reasoning.

A design-led approach is particularly relevant to this educational ambition. Design ethnography and research-through-design frameworks emphasize situated inquiry, iterative experimentation, and the generation of knowledge through practice.[8,13] Research through co-design further strengthens this orientation by framing knowledge production as a collaborative process in which participants do not simply receive predefined content, but actively shape understandings and possible responses together.[9] In this sense, educational practice becomes both a pedagogical intervention and a mode of inquiry.

Applied to textile bioeconomy, this means that learners are not only told about circularity, waste, or regenerative futures. They are invited to map local systems, examine material flows, identify problems, explore alternatives, and prototype awareness actions or educational artefacts grounded in their own context. This is especially important in territories such as the Vale do Ave, where industrial transformation is inseparable from local memory, skills, labour histories, and future opportunities. The term regenerative, as used here, should therefore be understood carefully. The programme does not claim to produce regenerative outcomes in a direct or measurable systemic sense. Rather, it seeks to cultivate the social and educational conditions that may support such transitions over time: more informed consumers, more conscious decision-making, stronger territorial connection, a less reductive view of the textile sector, and greater sensitivity to the relationship between materials, industry, and planetary impact. In this sense, regenerative textile bioeconomy education operates as an early-stage infrastructure for systemic change, not as proof that change has already occurred.

Methodology

This study adopts a qualitative design-led case study approach to examine how an educational programme focused on textile systems and regenerative bioeconomy education emerged and was developed within the be@t – Bioeconomy at Textiles project. The research was informed by an ethnographic perspective, in that it sought to understand situated educational realities, stakeholder concerns and local practices before defining the intervention itself. At the same time, the study draws on a research-through-design framework, as the educational activities were not only means of dissemination but also means of inquiry through which practice-based knowledge was generated.

The methodological process unfolded in four interconnected stages (Figure 1). The first stage consisted of contextual inquiry, through which the research team engaged with

teachers, educators, trainers and higher education actors in order to identify existing practices, perceived gaps and opportunities related to textile sustainability, waste, and bioeconomy themes. This stage made visible a demand for textile-focused educational action that had not initially been central to the project structure.

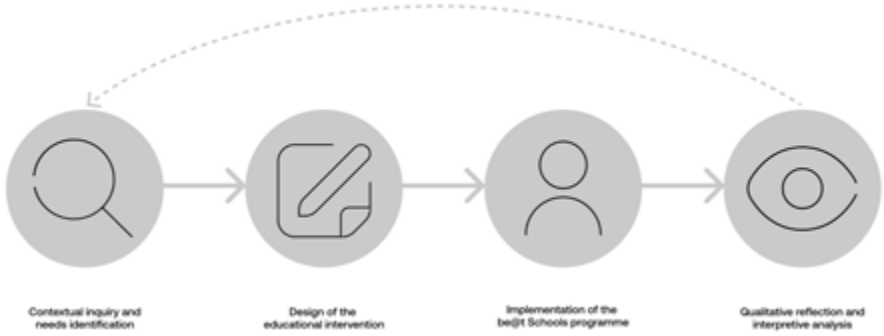

Figure 1 - Methodological process

The second stage involved the design of the educational intervention. Based on the identified needs, the team developed participatory and practice-based activities adapted to different educational levels. These activities were designed to encourage systems thinking, local relevance, material engagement and future-oriented reflection.

The third stage consisted of the implementation of the be@t Schools programme across primary, secondary, and higher education settings. Activities included guided mapping of school-based textile waste and practices, exploration of biomaterials, mapping of local textile ecosystems and co-creation workshops aimed at developing educational materials and awareness-raising actions. Students, teachers, facilitators, and, where feasible, external stakeholders participated in these processes.

The fourth stage focused on qualitative reflection and interpretive analysis of the materials generated during and immediately after the activities, including observation notes, facilitation records, participant reflections, visual mappings, workshop artefacts, and co-created outputs. These materials were examined in order to identify recurring patterns in how participants framed textile-system issues, connected social, environmental, and economic dimensions, and articulated systemic and future-oriented perspectives.

Case study - be@t schools

The programme was implemented across primary, secondary and higher education contexts within the region of Vale do Ave and aimed to promote participatory and practice-based engagement with textile-related issues (Figure 2). A common baseline structure was used in all settings, consisting of an introductory presentation to the be@t project and a set of key themes, including consumption, textile waste, R-strategies, circular economy, bioeconomy, biomaterials, ecodesign and eco-engineering. However, the activities were adapted according to the age group, learning context and institutional profile of participants. In primary education, the approach was more interactive and practice-based, with extended engagement through activities such as collages and the remaking of garments, often with the support of teachers and families. In secondary education, the programme followed a more classroom-based format, combining material samples, case studies and interactive discussion sessions. In higher education, the activities were more comprehensive and discipline specific. Sessions were adapted to the profile of each institution visited, such as economics, design, engineering or social sciences, and were supported by researchers with relevant expertise in order to connect the broader aims of the be@t project with field-specific knowledge of the students and competences related to the textile industry.

Figure 2 - the be@t programme in primary, secondary and higher education

Rather than functioning as a standardised awareness package, the programme operated as an adaptive educational platform, shaped by the age, disciplinary profile, and institutional context of participants. This flexibility was central to the design-led character of the intervention and to its capacity to generate situated forms of learning and reflection.

Findings and discussion

The qualitative reading of the materials produced during the programme suggests four main tendencies.

First, the activities helped make textile systems more visible. For many participants, textiles initially appeared mainly as finished consumer objects, disconnected from production processes, labour conditions, environmental impacts, and end-of-life trajectories. Through mapping, discussion, and material exploration, garments became increasingly understood as parts of broader systems involving raw materials, manufacturing, logistics, use, disposal, and potential recirculation. This shift does not demonstrate deep behavioural transformation, but it does indicate an expansion in the way textile issues were cognitively framed (Internal project documentation).

Second, the programme appeared to support a re-signification of the local textile sector. In several contexts, participants began from a relatively narrow or dated view of textiles, often linked to repetitive industrial work or a low-value sectoral image. As activities connected local know-how, innovation, export capacity, biomaterials, and circularity, this image became more complex. Textiles were more frequently discussed not only as a legacy sector, but also as a transforming field with contemporary relevance. In the Vale do Ave context, this is particularly significant because educational awareness is intertwined with how a territory imagines its own economic and social future.[10,11]

Third, responsibility was increasingly articulated across multiple stages of the textile lifecycle. Initial discussions often focused on waste disposal alone. Over time, participants more frequently referred to purchase decisions, durability, care, repair, reuse, material choices, sorting, and the conditions under which a product might have a second life or become waste. This suggests that the programme may have helped broaden responsibility from end-of-pipe thinking toward a more systemic understanding of consumption and circularity. In this respect, the educational value of the programme lies less in transmitting isolated environmental facts and more in reorganizing how textile responsibility is distributed across design, production, consumption, and end-of-life.[6]

Fourth, the findings also reveal important limitations. The observed changes were mainly discursive, interpretive, and immediate. No quantitative assessment was conducted, and no longitudinal follow-up was undertaken. It is therefore not possible to claim durable changes in behaviour, educational pathways, or territorial transformation. This limitation is not marginal; it is central to how the case study should be read. The programme can point to emergent shifts in language, perception, and systems awareness, but the more substantial effects that matter most, such as more conscious consumption, stronger attraction to transformed sectoral careers, or wider community change, would only become visible over a much longer time horizon.

These limitations, however, do not invalidate the relevance of the approach. On the contrary, they highlight the nature of the contribution. The programme should be understood as a design-led, exploratory educational infrastructure capable of connecting schools, research, local industry, and societal transition in a territorially meaningful way. Its value lies in creating conditions for reflection and reframing, especially in a context

where textile awareness is not only about environmental impacts but also about repairing a weakened social relationship between territory and sector. From this perspective, the be@t Schools case supports the argument that regenerative textile bioeconomy education may be especially meaningful in historically industrial territories. In such places, educational work is not only about explaining circularity. It is also about negotiating memory, identity, aspiration, and legitimacy. A design-led approach is useful precisely because it allows these dimensions to be approached through situated practices, collaborative inquiry, and material engagement rather than through abstract policy discourse alone.

Conclusion

This paper examined the be@t Schools programme as a design-led educational case study developed within the be@t – Bioeconomy at Textiles project. It argued that schools and local learning ecosystems can operate as early-stage infrastructures for regenerative textile bioeconomy transitions, particularly in territories where textiles remain historically, economically, and culturally significant.

The case of the Vale do Ave helps clarify why this matters. In this context, the challenge is not only to inform students and communities about textile waste, circularity, or bio-based alternatives. It is also to address a more complex territorial condition: a region with deep textile know-how and strong industrial relevance, but where parts of society have come to associate the sector with an older and less valued labour model. Regenerative textile bioeconomy education, as proposed here, responds to both dimensions by linking environmental literacy, systems thinking, territorial awareness, and cultural re-signification.

The contribution of this study is therefore primarily methodological and conceptual. It does not demonstrate long-term impact, nor does it claim measurable regenerative outcomes. Instead, it shows how an educational programme can be framed and analysed as a design-led inquiry into the social conditions that may support transformation over time. It also suggests that awareness-raising in textile regions should not be treated as a secondary communication activity, but as part of the transition infrastructure itself.

Future research should build on this exploratory case through longitudinal and comparative approaches capable of examining whether and how such programmes influence attitudes, practices, educational choices, and local engagement over longer periods. It should also investigate how schools, higher education institutions, industry, and municipalities can collaborate more systematically in creating textile bioeconomy learning ecosystems adapted to specific territorial realities.

Bibliography

European Environment Agency. (2025, March 26). *Circularity of the EU textiles value chain in numbers.* https://www.eea.europa.eu/en/analysis/publications/circularity-of-the-eu-textiles-value-chain-in-numbers

AICEP Portugal Global. (2024). *Textiles & clothing industry report.* https://www.portugalglobal.pt/media/ucsads3k/textiles-clothing-industry-report.pdf

Moreira, L., Galvão, A. R., Braga, V., Braga, A., & Teixeira, J. (2023). S*ustainability as a gateway to textile international markets: The Portuguese case.* Sustainability, 15(5), Article 4669. https://doi.org/10.3390/su15054669

Ribeiro, V. M., & Soares, I. (2024). *Internal competitiveness and market leadership in the adoption of green technologies in the Portuguese textiles and apparel industry.* Sustainable Energy Technologies and Assessments, 69, Article 103899. https://doi.org/10.1016/j.seta.2024.103899

Izsak, K., & Moreno, C. (2024). *Monitoring the twin transition of industrial ecosystems: Textiles analytical report.* European Monitor of Industrial Ecosystems. https://monitor-industrial-ecosystems.ec.europa.eu/sites/default/files/2024-01/EMI%20Textiles%20industrial%20ecosystem%20report.pdf

Câmara, A. C., Proença, A., Teixeira, F., Freitas, H., Gil, H. I., Vieira, I., Ramos Pinto, J., Soares, L., Gomes, M., Gomes, M., Amaral, M. L., & Tavares de Castro, S. (2018). *Referencial de Educação Ambiental para a Sustentabilidade para a Educação Pré-Escolar, o Ensino Básico e o Ensino Secundário* (J. V. Pedroso, Coord.). Direção-Geral da Educação. https://www.dge.mec.pt/sites/default/files/ECidadania/Educacao_Ambiental/documentos/referencial_ambiente.pdf

CITEVE. (2025). *Sustainability report 2025. be@t – Bioeconomy at Textiles*. https://static.citeve.pt/share/2026-02/31eef65c-a86f-4a52-ac20-325df1d0b2d9/4f76aef0-abba-497e-a691-be77860e0239/en_gb__file/bcc11bbf-1e10-4c1d-addb-e124403acd32/20260204141616/RS_be@t_2025_EN%201%201.pdf

Müller, F. (2021). *Design ethnography: Epistemology and methodology*. Springer. https://doi.org/10.1007/978-3-030-60396-0

Busciantella-Ricci, D., & Scataglini, S. (2024). *Research through co-design. Design Science, 10*, e3. https://doi.org/10.1017/dsj.2023.35

Alves, J. F. (2012). *Fiar e tecer: Uma perspectiva histórica da indústria têxtil a partir do Vale do Ave.* Câmara Municipal de Vila Nova de Famalicão/Museu da Indústria Têxtil.

Pereira, V. B. (Ed.). (2012). *Ao cair do pano: Sobre a formação do quotidiano num contexto (des)industrializado do Vale do Ave.* Afrontamento.

Barroso-Hurtado, D., Pažur, M., & Ribeiro, A. B. (2022). Negotiating "employability" in Europe: Insights from Spain, Croatia and Portugal. In S. Benasso, D. Bouillet, T. Neves, & M. Parreira do Amaral (Eds.), *Landscapes of lifelong learning policies across Europe* (pp. 165–190). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-96454-2_8

Maher, R., Maher, M., Mann, S., McAlpine, C. A., & Seabrook, L. (2018). *Integrating design thinking with sustainability science: A research through design approach.* Sustainability Science, 13, 1565–1587. https://doi.org/10.1007/s11625-018-0618-6

Resumen: Este artículo presenta un estudio de caso de investigación basado en el diseño, desarrollado en el marco del proyecto be@t - Bioeconomía en la Industria Textil, a través de un programa de sensibilización escolar que abarca la educación primaria, secundaria y superior en el norte de Portugal, una región donde la industria textil representa un ecosistema sociotécnico de gran importancia histórica y económica. Enmarcado en los debates sobre diseño más allá de la sostenibilidad, diseño regenerativo y economías regenerativas, el estudio argumenta que los entornos educativos pueden funcionar como infraestructuras iniciales para el cambio sistémico, al moldear capacidades, valores y relaciones locales que apoyen las vías de la bioeconomía textil regenerativa. En este artículo, "educación en bioeconomía textil regenerativa" se refiere a enfoques educativos que introducen los principios de la bioeconomía circular y el diseño regenerativo en contextos textiles, fomentando el pensamiento sistémico sobre materiales, cadenas de valor y opciones de fin de vida **útil** en relación con las realidades socioeconómicas y ambientales locales. Fundamentado en una perspectiva etnográfica y un marco de investigación a través del diseño, el estudio investiga cómo las metodologías participativas y basadas en la práctica permiten a los estudiantes desarrollar comprensiones sistémicas, críticas y orientadas al futuro de la producción textil, los residuos y los principios de la bioeconomía circular. El programa involucró a los estudiantes como agentes de cambio activos a través de actividades prácticas como el mapeo guiado en la escuela de los residuos y las prácticas textiles, la exploración de materiales con biomateriales, el mapeo de los ecosistemas textiles locales y talleres colaborativos que involucraron, cuando fue posible, a partes interesadas externas. Los talleres de cocreación reunieron a estudiantes, maestros, facilitadores de educación superior y socios de la industria para prototipar materiales educativos y acciones de concientización a pequeña escala, incorporando la reflexión iterativa, el aprendizaje mediante la práctica y la exploración especulativa de futuros textiles regenerativos. Una lectura cualitativa de los materiales sugiere cambios en la forma en que los estudiantes y educadores articularon los desafíos del sistema textil, incluyendo una mayor atención a las dimensiones sociales, ambientales y económicas y un uso más frecuente de lenguaje sistémico y orientado al futuro. No se realizó ninguna evaluación cuantitativa; Los resultados reportados se limitan, por lo tanto, a conocimientos prácticos y reflexiones observadas o autoinformadas durante y después de las actividades. El artículo analiza el valor y las limitaciones de este enfoque de diseño para conectar la educación, la investigación y la práctica comunitaria, y describe un modelo metodológico adaptable a otros contextos, sujeto a los recursos y las alianzas locales.

Palabras clave: Investigación a través del diseño - bioeconomía textil - residuos textiles - diseño regenerativo - educación en bioeconomía circular - sensibilización - innovación social

Resumo: Este artigo apresenta um estudo de caso de pesquisa orientada pelo design, desenvolvido no âmbito do projeto be@t - Bioeconomia em Têxteis, através de um programa de sensibilização nas escolas, abrangendo o ensino fundamental, médio e

superior no Norte de Portugal, uma região onde a indústria têxtil e de vestuário representa um ecossistema sociotécnico historicamente e economicamente significativo. Inserido nos debates sobre design para além da sustentabilidade, design regenerativo e economias regenerativas, o estudo argumenta que os ambientes educativos podem funcionar como infraestruturas iniciais para a mudança sistémica, moldando capacidades, valores e relações locais que apoiam os caminhos da bioeconomia têxtil regenerativa. Neste artigo, "educação para a bioeconomia têxtil regenerativa" refere-se a abordagens educativas que introduzem os princípios da bioeconomia circular e do design regenerativo em contextos têxteis, apoiando o pensamento sistémico sobre materiais, cadeias de valor e opções de fim de vida em relação às realidades socioeconómicas e ambientais locais. Fundamentado numa perspectiva etnográfica e numa estrutura de pesquisa-aplicação ao design, o estudo investiga como metodologias participativas e baseadas na prática permitem que os alunos desenvolvam compreensões sistêmicas, críticas e orientadas para o futuro sobre a produção têxtil, os resíduos e os princípios da bioeconomia circular. O programa envolveu os alunos como agentes ativos de mudança por meio de atividades práticas, como mapeamento guiado de resíduos e práticas têxteis em ambiente escolar, exploração de materiais com biomateriais, mapeamento de ecossistemas têxteis locais e oficinas colaborativas que envolveram, quando viável, partes interessadas externas. Oficinas de cocriação reuniram alunos, professores, facilitadores do ensino superior e parceiros da indústria para prototipar materiais educativos e ações de conscientização em pequena escala, incorporando reflexão iterativa, aprendizado prático e exploração especulativa de futuros têxteis regenerativos. Uma leitura qualitativa dos materiais sugere mudanças na forma como alunos e educadores articularam os desafios do sistema têxtil, incluindo maior atenção às dimensões sociais, ambientais e econômicas e uso mais frequente de linguagem sistêmica e orientada para o futuro. Nenhuma avaliação quantitativa foi realizada; os resultados relatados, portanto, limitam-se a percepções baseadas na prática e reflexões observadas ou autorrelatadas durante e imediatamente após as atividades. Este artigo discute o valor e as limitações dessa abordagem orientada pelo design para conectar educação, pesquisa e prática comunitária, e descreve um modelo metodológico que se pretende adaptável a outros contextos, sujeito aos recursos e parcerias locais.

Palavras-chave: Investigação através do design - Bioeconomia têxtil - Resíduos têxteis - Design regenerativo - Educação para a bioeconomia circular - Sensibilização - Inovação social.

[Las traducciones de los abstracts fueron supervisadas por el autor de cada artículo.]

Raquel Santos. Researcher and entrepreneur working across design, engineering and science to advance sustainability and circularity in fashion and textiles sector. At CITEVE*, she contributes to national and European R&D projects and leads the Design for Circularity Standard of CEN/TC 248/WG 39, helping drive systemic change in the textile sector. Her research, recognized by the Calouste Gulbenkian Foundation and Iberoamérica

Teresa Luísa Silva. Researcher at CITEVE* working at the intersection of biology, sustainability, and textile innovation. She holds a degree in Biology and a PhD in Biodiversity, Genetics and Evolution, and has extensive experience in molecular biology, R&D projects, science communication, and stakeholder engagement. Her current work focuses on sustainability, circular bioeconomy, and awareness-raising initiatives connected to the transformation of the textile sector.

Carla Joana Silva. Director of the Chemistry and Biotechnology Department at CITEVE. She holds a degree in Biological Engineering, an MSc in Industrial Biotechnology and a PhD in Textile Chemistry. With more than 25 years of experience in applied and industry-oriented research, she has coordinated multiple national and international R&D projects in areas including biotechnology, advanced materials, process optimization, sustainability, textile recycling, and circular bioeconomy.

(* Technological Centre of the Textile and Clothing Industries of Portugal).