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A methodological study in design didactics based on historical patterns of industrial textile heritage

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The aim of this study is to produce new and creative textile design proposals based on the reinterpretation of historical patterns from the archive of the Wool Museum at the University of Beira Interior. For this purpose, textile samples were selected from the archive according to the specific criteria: 100% wool composition, Batavian twill weave structure and houndstooth pattern design. In the following exercise, the design process model used was based on the Taxonomy of Significant Learning proposed by Dee Fink and variables such as technique, scale, colour and material were explored. The exercise was applied to forty undergraduate fashion design students, with a detailed analysis conducted on a representative sample of ten participants. The analysis was made through a mixed methodological approach that included inquiries, participant observation, and a qualitative evaluation of creative outcomes using Edward de Bono's theory of creative thinking. This study presents a methodological framework for the practice of fashion design rooted in industrial textile heritage, the exercise highlights the pedagogical value of integrating heritage-based design methods into higher education curricula, generating a creative and contemporary vision of the revitalisation of textile heritage. Ultimately, this work contributes to the advancement of cultural sustainability and pedagogical innovation in fashion design education, demonstrating the replicable potential of this exercise as a teaching model that connects industrial textile heritage with contemporary creative learning.

KEYWORDS

cultural sustainability, design practice, didactic, fashion, textiles

Introduction

In recent years, the integration of cultural heritage into fashion design education has been gaining increasing prominence, with particular emphasis on textile and clothing collections held in university museums (Brown and Vacca, 2022; Csanak, 2019; Marcketti and Gordon, 2023; Steele, 1998). These institutions serve as repositories of primary sources that are fundamental to the analysis of material culture and provide educational value by offering meaningful learning experiences for students (Lafrenz and Mida, 2013; Marcketti and Gordon, 2023).

The empirical dimension intrinsic to artefacts allows for the development of analytical and creative skills as well as the stimulation of critical thinking, thus constituting key elements for investigative practice in the field of fashion (Prown, 1982; Steele, 1998; Taylor, 1998).

However, despite the recognition of their value, the systematic application of these practices in teaching methodologies remains limited (Mida and Kim, 2015). The literature

points to a gap related to students' inexperience and lack of familiarity with interpreting material culture (Marcketti and Gordon, 2023; Steele, 1998; Yan and Li, 2023). It is also confirmed that design education continues to favour resources such as text and images, to the detriment of the analysis of artefacts through direct contact, as active sources of research (Marcketti and Gordon, 2023). Furthermore, observe that, although there is a valuable legacy of object-based research in the field of clothing, a clear and systematic structure for the study of artefacts in a replicable way in teaching has not yet been established. The absence of pedagogical frameworks tested in the classroom is also evident in the textile field, where the educational potential of fabrics and patterns remains underutilised.

At the same time, Brown and Vacca (2022) warn of the need to implement pedagogical practices that reconcile innovation and tradition, highlighting the growing role of digital technologies as facilitators of creative approaches, without devaluing heritage and its underlying technical and aesthetic dimension.

In this context, D'Itria and Vacca (2022) argue that the discipline of design, situated at the intersection between culture, consumption and change, has the capacity to decipher cultural transformations, anchoring itself in local specificities to better connect with future possibilities. By shaping cultural developments, design practices influence their drivers and patterns of change, acting as mediators between tradition and innovation.

In turn, Pistilli (2018) understands heritage as the result of a historical and intergenerational process, constituting a field of cultural production where heritage and creativity are intertwined. As a legacy of the past, heritage represents a crystallisation of values and practices, but simultaneously acts as a working tool and source of creativity for designers, enhancing the creation of new products. In this context, heritage is understood not only as historical testimony, but as creative heritage, a dynamic resource that feeds the contemporary creative process of designers.

Thus, this article presents the industrial textile archive of the Wool Museum of the University of Beira Interior, in fashion design teaching practices, through a methodological approach based on the Design Practice Model, developed on the basis of Fink (2013). The proposal focuses on the exploration and reinterpretation of the historical houndstooth pattern as a basis for the development of new textile design proposals, in an academic context and using manual processes and digital tools.

The relevance lies in the integration of textile material culture as an active resource in fashion design teaching, linking tradition and innovation. By proposing a structured model based on industrial textile heritage, this study contributes to reinforcing the dimension of cultural sustainability by promoting the connection between cultural legacy and contemporary practices in design. This approach is in line with the guidelines of D'Itria and Vacca (2022), who advocate the need to integrate new processes without compromising the uniqueness of heritage, and with Pistilli (2018), who recognises heritage as a driver of creativity and cultural production.

In addition, this study proposes a reflection on the role of the designer as an agent of industrial heritage regeneration, highlighting the educational potential of direct contact with historical artefacts in the development of creative and critical skills. By integrating textile heritage into fashion design education, the aim is to contribute to the

construction of a more experiential, reflective and sustainable pedagogy that promotes the development of culturally aware and technically versatile designers.

It reveals a replicable and future-oriented methodology, with an impact on innovation and creativity in textiles in the creative process of fashion design through the regeneration of industrial textile heritage.

The article is structured in four main sections. The following section presents, in detail, the methodology adopted and a description of the experience. Next, the results developed by the students are analysed. Finally, the research discussion section is presented, in which future guidelines for its application in similar contexts are proposed.

Materials and methods

Preparation of materials

The study was conducted within the subject Fashion Design II, in the 3rd year of the Fashion Design degree at the University of Beira Interior (UBI), during the second semester of the 2023/2024 academic year. Initially, 40 students participated, but for the purposes of analysis, the work of 10 students who followed all stages of the exercise was considered.

This selection was made based on criteria of completeness and methodological consistency, namely: (i) full compliance with the four phases of the pedagogical model, (ii) delivery of the final artefacts (sketchbook, physical and digital textile samples) and (iii) participation in the final surveys.

All participants were informed of the educational and scientific objectives of the experiment and consented to the use of their work for research and academic dissemination purposes. The study fully complied with the ethical principles of the University of Beira Interior.

All classes took place at the University's Wool Museum. The choice of venue was strategic, as immersion in an environment that preserves and exhibits the history of textiles provides direct experience with industrial heritage, in line with the perspective of authors such as Falk and Dierking (2000), who defend the relevance of immersive experience for meaningful learning.

The pedagogical structure of the exercise was informed by the Taxonomy of Significant Learning proposed by Fink (2013). This framework was selected because it emphasises transformative learning processes that integrate cognitive, practical and reflective dimensions of knowledge, an approach particularly relevant in design education. Rather than focusing solely on the acquisition of technical skills, Fink's taxonomy promotes a multidimensional learning process involving foundational knowledge, application, integration and reflective awareness.

Recent research in design and material culture education has highlighted the relevance of this framework for teaching through historical artefacts and textile collections. In particular, studies such as Marcketti and Gordon (2023) emphasise how object-based learning can stimulate critical engagement with cultural heritage while fostering creative interpretation in the context of fashion design.

Based on these principles, a Design Practice Framework was developed to structure the Exploratory Exercise of Historical Patterns. The objective of this framework was to combine heritage-based analysis with experimental design practice, encouraging students to reinterpret historical textile patterns through contemporary creative processes.

The proposed model aims to promote experiential and transformative learning, combining textile heritage analysis, creative practices, and critical reflection. Thus, a mixed method approach was used (qualitative and quantitative), incorporating direct observation, practical production and structured assessment tools.

The experience was organised into four sequential stages: Comprehend, Replicate, Reinterpret and Materialise. The first stage, 'Comprehend', consisted of exploring and researching the textile archive of the University of Beira Interior Wool Museum.

Students were introduced to the museum's industrial textile collection. The houndstooth pattern was selected as the starting point due to its historical and contemporary relevance.

During this phase, students began documenting the learning process through sketchbooks, using graphic and descriptive records of the patterns analysed, applying systematic observation methodologies inspired by Prown (1982) and Steele (1998).

This theoretical practical dynamic integrates the sketchbook as the main methodological tool for documenting and analysing the creative process. Inspired by the working practices of renowned textile designer Zandra Rhodes, the sketchbook is understood as an instrument of continuous and exploratory development, where drawing acts as a means of thought and experimentation (Duff, 2013). Rhodes argues that the creative process should be conceived as a continuum, a visual journey that reveals both the final product and its intermediate stages, possessing documentary and symbolic value.

In design education, sketchbooks are widely recognised as instruments for documenting iterative creative processes. Rather than serving merely as repositories of ideas, they allow students to externalise visual thinking, experiment with forms and record the evolution of design concepts. This documentation provides valuable insight into the progression from historical analysis to creative interpretation.

In convergence with this perspective, De Bono (1999) emphasises that creativity lies in experimentation and the intentionality of the process, rather than in the finished result. Creativity is thus understood as a cognitive and experiential journey that can be trained and documented. This notion finds a parallel in the diagrammatic and relational theory proposed by Amandi and Almeida (2021), according to which the creative process manifests itself as a graphic and spatially diagrammatic system. Creation develops through dynamic relationships between visual, material and conceptual elements—drawings, collages, photographs, notes and samples—that form an operational network of visual thinking, in which drawing takes on a structuring role as a recording tool.

In this context, the sketchbook is understood as a micro-cartography of the creative process, a diagrammatic space that articulates fragments of thought and materiality, enabling the mapping of the conceptual and aesthetic journey.

Thus, in this research, the sketchbook is not only a repository of ideas, but an active methodological device. Its use allows the design process to be recorded and analysed from the first graphic explorations to the formal definition of the result. This methodology highlights the procedural, iterative and transformative nature of creation.

The second stage, "Replicate," deepened the formal and conceptual analysis of the historical pattern.

In this stage, the students proceeded with the visual and structural decomposition of the houndstooth pattern, identifying formal variables (technique, scale, colour) and conceptual variables (cultural meaning, historical context, possible contemporary application), experimenting with replication by manipulating the variables and producing different samples. The next stage corresponded to creative "Reinterpretation" and the development of new formal proposals.

The students developed new textile design proposals based on the houndstooth pattern, using a combination of manual techniques (fabric weaving) and digital tools (Adobe Illustrator and Photoshop). The aim of this stage was to foster the integration of historical knowledge with contemporary design practices.

The creative process was documented in individual sketchbooks, allowing the conceptual and technical evolution of each student to be monitored. This phase aimed to foster the integration of tradition and innovation, one of the central principles of the pedagogical model.

Finally, "Materialise" focused on applying the knowledge acquired in the development of critical thinking and autonomy skills. This final phase encourages reflective and continuous learning, preparing students to become lifelong learners (Fink, 2013).

This phase emphasised critical thinking, autonomy and the ability to translate conceptual ideas into tangible design outcomes, competencies aligned with the transformative learning objectives described by Fink (2013).

Throughout the process, students were encouraged to engage critically with historical textile archives and specialised literature available at the Wool Museum. This combination of archival research and experimental design practice by manipulating technical and aesthetic variables allowed students to connect heritage knowledge with contemporary creative production.

Two main axes stand out in this methodology: critical analysis in the manipulation of technical and aesthetic variables and systematic consultation of publications and historical collections of textiles and clothing from the University of Beira Interior Wool Museum. Critical experimentation with variables allows for the consolidation and application of theoretical and practical knowledge, while contact with the archive enriches research and informs design decisions.

Thus, the exercise structures the culmination of the learning process, integrating tradition, innovation and independent research in the training of conscious and reflective creators.

The results were evaluated by a team of five experts with experience in the fields of fashion design, textiles, design education and cultural heritage. The experts used an evaluation grid developed from Edward de Bono's principles

DESIGN PRACTICE FRAMEWORK for cultural sustainability

BASED ON THE 'SIGNIFICANT LEARNING TAXONOMY' BY FINK (2013)
APPLIED TO THE 'EXPLORATORY EXERCISE OF HISTORICAL PATTERNS'

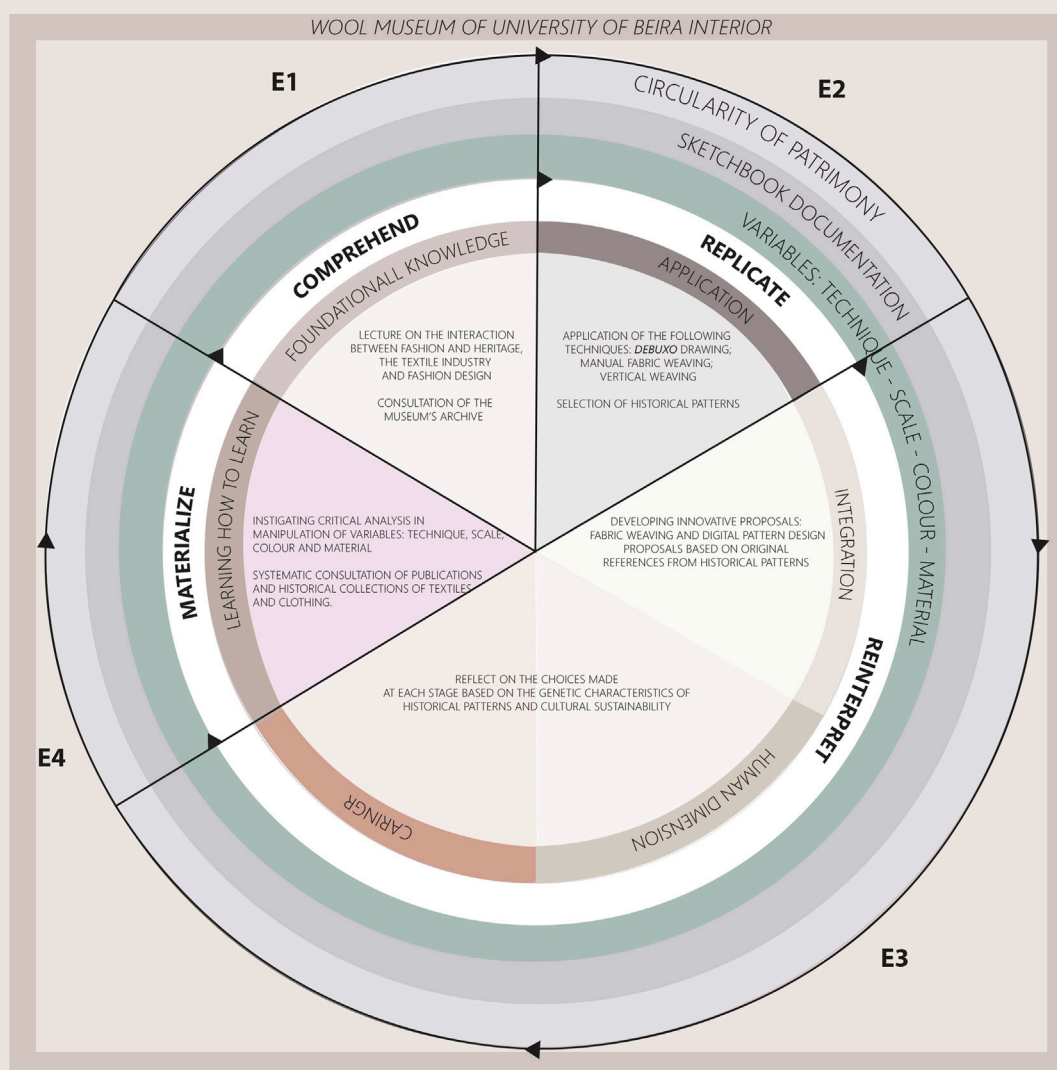


FIGURE 1
Design practice framework for cultural sustainability.

of creative thinking, namely the parameters of originality, conceptual clarity, flexibility of ideas, conscious management of the creative process, emotional expressiveness, and applicability.

The evaluation was complemented by a questionnaire completed by the students, with the aim of gathering perceptions about the learning process and the impact of the methodology.

The analysis of the data collected combined descriptive and interpretative approaches. The results of the questionnaires were summarised in percentages and simple averages, while the experts' evaluations were subjected to comparative analysis to verify convergence of opinions and evaluative consistency.

Production of the new design proposals

To carry out the exercise, the Design Practice Framework was developed based on Fink's Taxonomy of Significant Learning (2013) (see Figure 1), which consists of the following stages: E1- "Comprehend"; E2- "Replicate"; E3- "Reinterpret" and E4- "Materialise". Recycled fabrics and wool yarns from unused stocks or donated by textile factories in the region were used, promoting sustainable management of available resources.

E1 "Comprehend" | foundational knowledge

The first stage began with the cultural context of the Historical Archive of the Wool Museum of the University of Beira Interior and exploration of the Renée Delimbeuf collection, where students had access to a variety of textile samples that met specific criteria: 100% wool, batavia twill structure and houndstooth design, dating from 1960. To provide a holistic and diachronic analysis, editions of L'Officiel magazine from 1960 were consulted, in which the houndstooth pattern stands out as a prominent trend of the time. This analysis was complemented by observing fashion trends for Spring/Summer and Autumn/Winter 2025, taken from the trend magazine View 2025. This approach allowed students to understand the timeless nature of this pattern and its reinterpretation from the past to the future.

A detailed explanation was given on the origin of this pattern and analysis of the textile sample shown in Figure 2, taken from the reference book Winter 1937, Cota DF03/Lv97, as well as the respective *debuxo* (Figure 3). Observation of the *debuxo* corresponding to the pattern of the textile sample served as a basic example for explaining the process of technical representation of the pattern in the *debuxo*.¹

E2 "Replicate" | application

In the second stage, the students moved on to a practical dimension of the knowledge acquired, representing the houndstooth sketch on paper using contrasting markers, as shown in Figure 4.

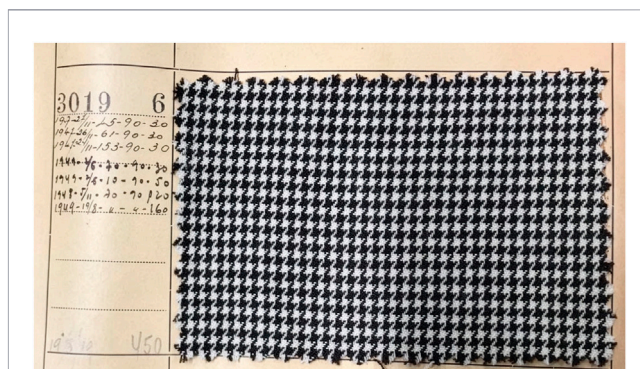


FIGURE 2
Textile sample Ref. 3019 6 from Winter 1937, Cota DF03/Lv97.

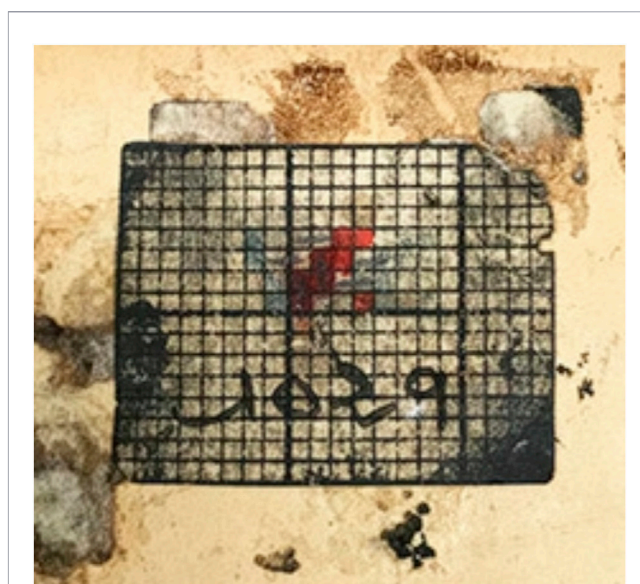


FIGURE 3
Debuxo.

The technical process of weaving with batavia twill fabric was presented. The initial practice consisted of weaving this structure on raw cloth, which allowed the students to familiarise themselves with the interweaving of the warp and weft, and later, using two colours, they wove the houndstooth pattern fabric (Figure 5).

Finally, they organised themselves into pairs and used vertical hand looms to weave the pattern in two colours with recycled wool yarns.

E3 "Reinterpret" | integration

In this stage of the exercise, students are challenged to reinterpret selected historical patterns, using the process of hand weaving fabric and digital drawing with Adobe Illustrator and Adobe Photoshop. The aim was to reinterpret the historical pattern by developing creative variations of it through fabric weaving, manipulating scale, colour, shape and texture. Students were asked to respect the colours of the chosen reference as much as possible (Figures 6, 7).

¹ Debuxo is a term used in the textile industry to refer to the technical drawing that guides the arrangement of threads (warp and weft) in the creation of textile patterns (Brahic, 1998).

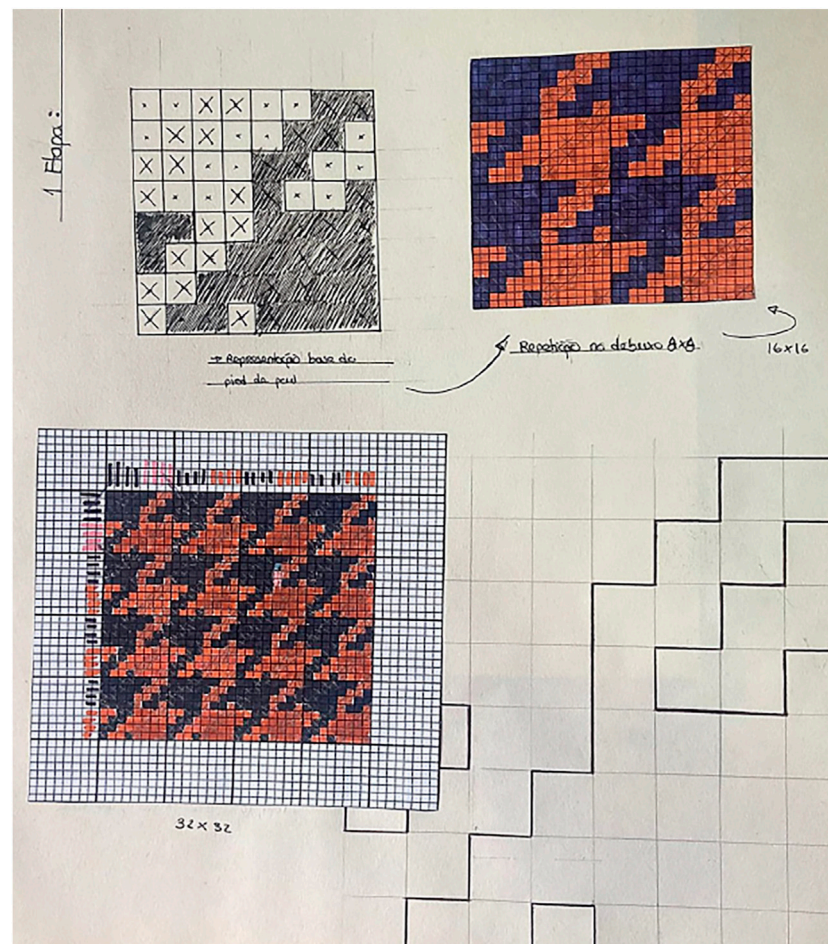


FIGURE 4
Page from student's sketchbook.

With regard to the development of woven patterns, five textile samples from the historical archive of the Wool Museum were pre-selected according to the following criteria: belonging to the René Delimbeuf collection; houndstooth pattern, 100% wool composition, batavia twill structure; dated 1960:

- Ref.8238
- Ref.8407
- Ref.8423
- Ref.8559
- Ref.8579

Students were asked to come up with at least four proposals for textile surfaces, using the fabric weaving technique, taking into account the following constraints: if they choose one of the multicoloured references Ref.8238, Ref.8407, or Ref.8559, they should select five colours present in the respective flag² and

proceed with textile experiments using five fabrics in those colours: four plain and one textured or shiny.

On the other hand, if they opt for the two-colour references Ref.8423 or Ref.8579, they should carry out textile experiments with only two colours, choosing two plain fabrics and three textured or shiny fabrics.

Still in stage E3 and following the reinterpretation approach, students were asked to develop at least four proposals for digital prints in rapport, based on the textile sample reference chosen by each one. They were asked to remain faithful to the colours and shape of the historical pattern (Figures 8, 9).

E3 "Reinterpret" | human dimension and caring

Also within the scope of stage E3 "Reinterpret" are the categories Human Dimension and Caring. These categories emphasise the importance of learning that relates to the development of humanistic characteristics, interactions and the student's ability to connect with the world (Fink, 2013). It is hoped that this same phenomenological understanding of the heritage revitalisation process will not only promote a broader view of the role of the designer from a holistic and culturally sustainable perspective, but also lead to a reflective

² In the context of industrial weaving, a flag refers to a fabric sample produced with colour variations to aid colour identification and collection development (Brahic, 1998).



FIGURE 5
Houndstooth on fabric weaving.

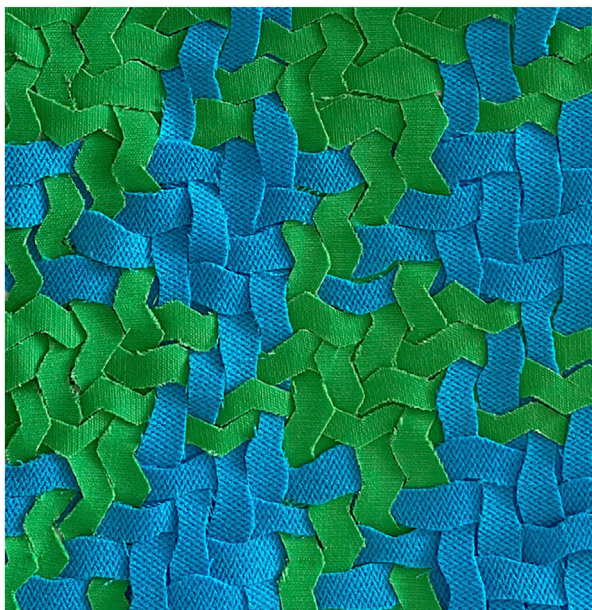


FIGURE 6
Houndstooth reinterpretation on fabric weaving.

approach on how historical elements can be reinvented for the contemporary world.

In this sense, students were asked to take a reflective stance throughout the design process by documenting their work in sketchbooks, culminating in the creation of several physical and digital samples.



FIGURE 7
Houndstooth reinterpretation on fabric weaving.

In the context of textile design, this dimension is essential for the following reasons: 1. Practising Culturally Sustainable Design: reinterpreting historical patterns can enable the transfer of know-how from the past to the future. It promotes the continuity of heritage preserved in museums, giving it new meanings and functions through its application in new methodologies. This approach can stimulate the practice of culturally sustainable design by sharing technical knowledge combined with a strong exploratory component in the creation of new proposals. 2. Awareness of Ethical Responsibility: reinterpretation, when based on an understanding of heritage, can give rise to new proposals that intrinsically incorporate a moral and cultural dimension, concerned with preservation and the continuity of transmission of testimony between generations. 3. Empathy and Understanding for Others: When encountering patterns that have cultural significance, students are invited to expand their empathy and understanding of industrial culture and textile creation in particular. They should consider the perspective of the original creator, René Delimbeuf, and the respective socio-cultural context in which these patterns were developed. This approach has the potential to cultivate an appreciation for cultural diversity and reinforce the importance of preserving this heritage through design.

E4 “Materialise” | learning how to learn

The “Materialise” stage focuses on Learning How to Learn. This final stage trains students to apply acquired knowledge and develop long-term skills that enable critical thinking. It promotes a reflective and critical approach, enabling students to become autonomous lifelong learners (Fink, 2013).

Two main axes stand out: critical analysis in the manipulation of technical and aesthetic variables and the systematic consultation of archival publications and historical

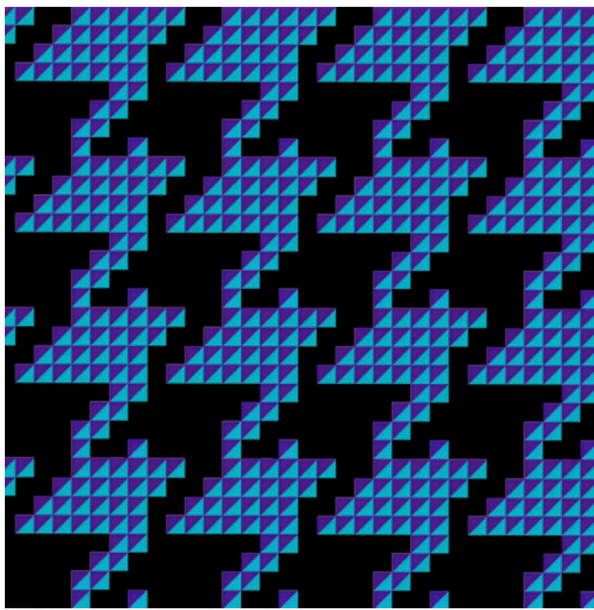


FIGURE 8
Houndstooth reinterpretation on digital media.

collections of textiles and clothing (Wool Museum of the University of Beira Interior). In the critical analysis of the manipulation of variables: the ability to manipulate variables such as technique, scale, colour and materials, central to E4, is considered. The incorporation of critical analysis in this process functions as a field of experimentation, where the theoretical and practical knowledge acquired in the previous stages is put into practice in a free manner. Mastery of these variables and understanding their potential can become essential for the student, contributing to their evolution and refinement of the design process. On the other hand, it is worth highlighting the systematic consultation of publications and historical collections of textiles and clothing from a research perspective and the analysis of publications, whether historical or contemporary, in the form of books, magazines, or periodicals, and textile collections in archives, which provide students with a rich context of content (Salvado, 2014). The archive, as a repository of information, allows for the cross-referencing of facts between the past and the present. Mastering this knowledge becomes essential in informing students' choices in the design process, especially when working with heritage. Systematic consultation also has the potential to refine independent research skills, deepening knowledge and familiarity with the respective sources.

Evaluation

The objective of this study is to integrate the industrial textile heritage preserved in the Wool Museum into fashion design education by creating new pattern design proposals based on the reinterpretation of historical patterns.

To evaluate the creative outcomes of the exercise, relevant literature in the fields of design methodology and creativity

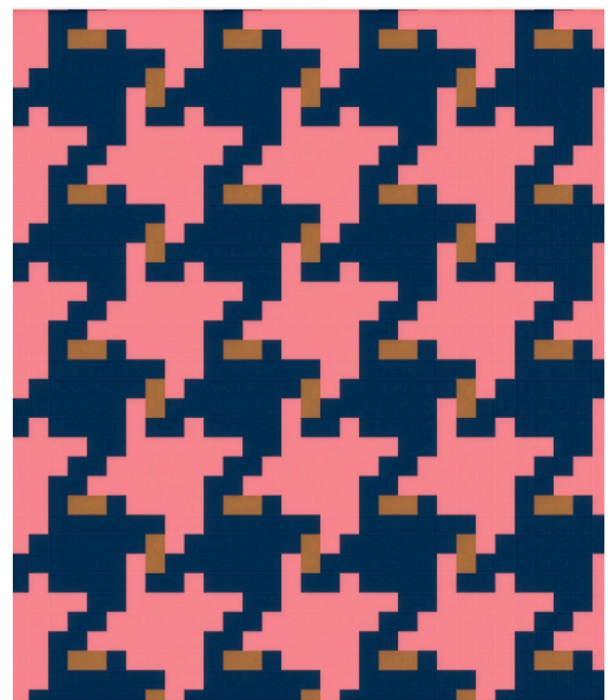


FIGURE 9
Houndstooth reinterpretation on digital media.

studies was analysed in order to identify criteria suitable for assessing both design processes and final results in a learning context. This approach was necessary because creativity in design education cannot be assessed solely through the final visual result, but must also consider the iterative and reflective nature of the creative process.

The resulting evaluation grid was based on Edward de Bono's approach to creative thinking, particularly the concepts of lateral thinking (De Bono, 2000) and Six Thinking Hats (De Bono, 1999). This emphasises the generation of alternative perspectives, and structured reflection in problem solving processes. These principles were considered relevant for this study because the pedagogical exercise required students not only to reproduce historical patterns but also to reinterpret them through exploratory and experimental design strategies.

Six evaluation criteria were defined: *Originality*, *Conceptual Provocation*, *Cognitive Flexibility*, *Creative Process Management*, *Emotional Expression*, and *Result Feasibility* (Table 1). Together, these criteria were intended to capture different dimensions of creativity relevant to textile design practice, including ideation, conceptual development, process documentation and practical applicability.

Each criterion was translated into the specific context of textile design and its respective process through observable indicators that allowed for a structured analysis of the creative process, beyond the mere visual result.

This operationalisation of the criteria aimed to make the evaluation process more transparent and consistent across different evaluators.

The resulting framework enabled a broader understanding of creativity as a developable and reflective capability rather than a

TABLE 1 De Bono's evaluation table.

Evaluation scale 5 = excellent; 4 = very good; 3 = good; 2 = unsatisfactory; 1 = not applicable						
Evaluation criterion	Originality in approach	Conceptual provocation and conceptual challenge	Cognitive flexibility and adaptation of ideas	Creative process management	Emotional/intuitive expression	Result feasibility and applicability
	Unexpected use of shapes, colours or compositions	Questioning traditional norms of composition or technique	Exploration of various possibilities before deciding	Documentation of the process (records, visuals, notes, sketches)	Presence of sensitive, affective or symbolic elements	Awareness of practical application
	Unusual combinations of visual or symbolic references	Inclusion and provocative elements (visual, symbolic, or cultural)	Ability to abandon or transform ideas that do not work	Clarity in decisions made at different stages of the project	Correspondence between emotional intentions and visual language used	Balance between innovation and functionality
		Exploration of paradoxical or disruptive ideas that open up new meanings	Creative adaptation to problems that arise in the process	Critical reflection on creative choices	Coherence between form and reference to historical patterns	

purely spontaneous outcome. In this sense, the evaluation model aligns with pedagogical approaches in design education that emphasise experimentation, iterative learning and critical reflection as key components of creative development.

Thus, the evaluation strategy adopted in this study considered design simultaneously as a process and as a product, allowing the analysis to capture both the conceptual trajectory of the students' work and the feasibility of the resulting design proposals.

Evaluation of creativity in patterns based on Edward de Bono

The evaluation team consisted of five experts with over 9 years of professional experience in the field of textiles and design (Table 2). The evaluations were carried out independently in order to ensure that the evaluators' judgments did not influence each other.

The evaluation framework was based on the creative thinking theories proposed by Edward de Bono, particularly the concepts of lateral thinking and the Six Thinking Hats model. According to De Bono, creativity should not be understood as a spontaneous talent but rather as a cognitive ability that can be structured and developed through deliberate thinking strategies (De Bono, 1992; De Bono, 1999; De Bono, 2000). These approaches emphasise the intentional organisation of thought, the exploration of alternative perspectives and the ability to move beyond established patterns in order to generate innovative ideas.

Based on these theoretical principles, six evaluation criteria were defined and adapted to the context of textile pattern design (Table 1). Each criterion corresponds to a dimension of creative thinking proposed by De Bono and was translated into observable indicators that allowed the experts to assess both the creative process and the final design outcomes.

The first criterion, Originality of Approach (Lateral Thinking), evaluates the student's ability to propose unconventional solutions that depart from predictable visual or thematic patterns. Observable indicators include the unexpected use of shapes, colours or compositions and unusual combinations of visual or symbolic references. Lateral thinking involves breaking habitual mental patterns and exploring alternative ways of solving problems (De Bono, 2000).

The second criterion, Capacity for Provocation and Conceptual Challenge, assesses the student's ability to challenge aesthetic, technical or thematic conventions in the development of new proposals. Observable indicators include questioning traditional norms of composition or technique, introducing provocative visual or symbolic elements, and exploring paradoxical or disruptive ideas that generate new meanings. De Bono identifies deliberate provocation as an important strategy for stimulating creative thinking (De Bono, 1992).

The third criterion, Cognitive Flexibility (Movement), evaluates the ability to generate, explore and adapt multiple ideas throughout the creative process rather than fixing initially on a single solution. Indicators include the exploration of different possibilities before decision making, the capacity to transform ideas, and the ability to respond creatively to challenges that arise during the process. In De Bono's theory, "movement" represents the exploration of where an idea may lead before evaluating it (De Bono, 1992).

The fourth criterion, Conscious Management of the Creative Process (Blue Hat- Metacognition), examines the student's ability to organise and reflect on their creative process. Observable indicators include the documentation of the process through sketches, visual records and notes, clarity in the decisions taken at different stages of the project, and critical reflection on creative choices. In the Six Thinking Hats model, the blue hat represents the control of thinking processes and the organisation of creative activity (De Bono, 1999).

TABLE 2 The list of expert's information who evaluated the design proposals for reinterpreting historical patterns.

Expert	Education	Occupation	Work experience	Nationality
A	Bachelor's degree	Fashion designer (industry)	11 years	Portuguese
B	Master's degree	Fashion designer (industry)	14 years	Portuguese
C	Doctor's degree	Professor (academy)	15 years	Portuguese
D	Doctor's degree	Professor (academy)	9 years	Portuguese
E	Master's degree	Professor (academy)	12 years	Portuguese

TABLE 3 Evaluation factors for the digital processes for reinterpreting historical patterns.

Factors of digital design methods	Questions
The difficulty of digital design methods	-How difficult is the digital design method overall? (Very difficult, difficult, normal, easy, very easy)
The degree of understanding of digital design process	-What is the percentage of understanding about the digital design process? (0%, 25%, 50%, 75%, 100%)
How much enjoyment or boredom was experienced in the digital design process	-How much enjoyment or boredom is experienced in the digital design process? (Very boring, boring, normal, fun, very fun)

The fifth criterion, Emotional and Expressive Exploration (Red Hat), evaluates the incorporation of emotional, intuitive and subjective dimensions into the design proposals. Indicators include the presence of sensitive or affective elements, the coherence between emotional intention and visual language, and the expressive interpretation of historical references. The red hat represents intuitive and emotional thinking as a legitimate dimension of the creative process (De Bono, 1999).

The sixth criterion, Feasibility and Applicability of the Result (Yellow and Black Hats), assesses the practical potential of the design proposals as well as the awareness of their limitations. Observable indicators include the balance between innovation and functionality and the consideration of practical implementation. Within the Six Thinking Hats framework, the yellow hat represents constructive and optimistic thinking, while the black hat represents critical and cautious evaluation of potential risks (De Bono, 1999).

In addition to expert evaluation, a questionnaire was administered to students in order to assess the design processes and their replicability in an educational context. Inspired by the study of Lee (2023), the questionnaire examined three main factors for both digital and manual design methods: the perceived difficulty of execution, the level of understanding of the processes involved, and the degree of enjoyment or boredom experienced during the activities (Tables 3, 4).

Results

The assessments of the five experts were analysed based on Edward de Bono's six criteria for creativity, developed and adapted into a grid format for this study.

Overall, the results indicate a moderate to high level of performance among the students, with average scores ranging between 3.7 and 4.0 on a five-point scale (Table 5).

Three criteria, Conscious Management of the Creative Process, Emotional/Intuitive Expressiveness and Feasibility and Applicability of the Solution, obtained the highest average values (4.0). These results suggest that students demonstrated strong abilities in documenting and organising their creative process, translating emotional or intuitive intentions into visual outcomes, and producing solutions that were technically and conceptually viable.

The prominence of these criteria is related to the pedagogical structure of the exercise, which emphasised process documentation through sketchbooks and iterative experimentation. In this sense, the methodology appears to have supported students in developing reflective and procedural aspects of design practice.

In contrast, the criteria Originality in Approach, Provocation and Conceptual Challenge, and Cognitive Flexibility obtained slightly lower averages (between 3.7 and 3.8). Although these values still indicate positive performance, they suggest that students encountered greater difficulty in producing more disruptive reinterpretations of the historical reference pattern.

This tendency may reflect the challenge of balancing respect for historical textile structures with the development of more experimental or conceptually provocative design proposals. The results therefore indicate that future iterations of the exercise could place greater emphasis on strategies that stimulate conceptual risk-taking and exploratory thinking in the early phases of the creative process.

Overall, the results suggest that the pedagogical model was particularly effective in supporting process management and the translation of ideas into feasible design outcomes, while the development of higher levels of conceptual experimentation remains an area for further pedagogical exploration.

To assess the consistency of the evaluations assigned by the five experts to the 10 students, Kendall's coefficient of concordance (W) was calculated, which measures the degree of agreement between evaluators in the ordering of items. The result obtained was $W = 0.624$, indicating moderate to good agreement among the experts. This value shows that,

TABLE 4 | Evaluation factors for the manual processes for reinterpreting historical patterns.

Factors of manual methods	Questions
The difficulty of manual methods	-How difficult is the manual method overall? (Very difficult, difficult, normal, easy, very easy)
The degree of understanding of manual process	-What is the percentage of understanding about the manual process? (0%, 25%, 50%, 75%, 100%)
How much enjoyment or boredom was experienced in the manual process	-How much enjoyment or boredom is experienced in the weaving process? (Very boring, boring, normal, fun, very fun)

TABLE 5 | Average results per evaluation criterion of De Bono's table.

Criterion	Average
1 Originality in approach	3.8
2 Provocation and conceptual challenge	3.7
3 Flexibility and adaptation of ideas	3.7
4 Conscious management of the creative process	4.0
5 Emotional/Intuitive expressiveness	4.0
6 Feasibility and applicability of the solution	4.0

despite some individual variation, there is a clear tendency to agree on the students with the highest creative performance, reinforcing the consistency and validity of the assessment grid used.

The evaluation of manual and digital weaving methods was carried out by the same students who participated in the Exploratory Exercise on Historical Patterns.

Regarding the degree of difficulty experienced by participants in using the digital tools Adobe Illustrator and Photoshop, the responses were positive (Table 6). Three of the respondents rated the experience as 'normal' in terms of difficulty, while the majority (seven participants) indicated that they found the task "easy". There were no responses in the categories "very difficult", "difficult" or "very easy", which suggests a perception of relative accessibility in the use of these tools for the proposed purposes.

With regard to the percentage of understanding of the historical pattern representation in digital media, the data points to a high level of understanding on the part of the participants. Eight of the respondents (80%) stated that they had achieved 100% understanding of the process, while the remaining two (20%) indicated an understanding of 75%. There were no responses in the options corresponding to 50% or 0%–25%, which reinforces the effectiveness of digital media as a means of expression and graphic representation in this context.

Regarding the degree of enjoyment or boredom experienced during the process of designing the historical pattern in a digital environment, a positive trend was observed. Four participants (40%) rated the experience as "normal", while six (60%) considered it "fun". There were no responses in the categories "very boring", "boring" or "very

TABLE 6 Results of the digital processes for reinterpreting historical patterns.

Factors of digital design methods	Questions
The difficulty of digital design methods	Very difficult (0%), difficult (0%), normal (30%), easy (70%), very easy (0%)
The degree of understanding of digital design process	0%–25% understood (0%), 50% understood (0%), 100% understood (80%), 75% understood (20%)
How much enjoyment or boredom was experienced in the digital design process	Very boring (0%), boring (0%), normal (40%), fun (60%), very fun (0%)

TABLE 7 Results of the manual processes for reinterpreting historical patterns.

Factors of manual methods	Questions
The difficulty of the manual methods	Very difficult (0%), difficult (10%), normal (30%), easy (50%), very easy (10%)
The degree of understanding of the manual process	0–25% understood (0%), 50% understood (0%), 100% understood (80%), 75% understood (20%)
How much enjoyment or boredom was experienced in the digital design process	Very boring (0%), boring (0%), normal (10%), fun (30%), very fun (60%)

fun", which suggests that the students were satisfactorily engaged with the proposed activity.

Concerning to the degree of difficulty experienced by participants during the manual execution of the historical pattern through weaving, the responses revealed an overall positive perception (Table 7). Most respondents (five participants) rated the experience as "easy", while three participants considered it to be of "normal" difficulty. There was also one response in the "difficult" category and one in the "very easy" category. No responses were given in the "very difficult" category, which shows that the participants adapted well to the manual technique, despite it requiring a certain degree of practical skill and motor coordination.

Considering the percentage of understanding of the historical pattern fabric weaving process, the data points to a high degree of comprehension on the part of the participants. Eight of the respondents (80%) stated that they had achieved 100% understanding, while two participants (20%) indicated an understanding of 75%. There were no responses in the options corresponding to 50% or 0–25%, which shows that, even in a manual execution context, participants were able to effectively assimilate the steps and principles underlying the weaving technique.

When it comes to the emotional involvement (fun/boredom) of participants during the weaving process, a markedly positive trend was observed. Six of the respondents (60%) rated the experience as "very fun," three (30%) considered it "fun," and only one participant (10%) rated it as "normal." There were no responses in the "boring" or "very boring" categories, suggesting a high level of motivation and

enjoyment in performing the manual activity, reinforcing the value of craftsmanship as a sensory and expressive experience in the context of historical pattern design.

Discussion

The results of the Exploratory Exercise on Historical Patterns provide insights into how heritage based learning can support the development of creative competencies in fashion design education. In general, the evaluation indicates that students performed particularly well in the criteria related to creative process management, emotional expression and feasibility of the final solutions.

At the same time, the strong performance in feasibility and applicability of solutions indicates that students were able to translate exploratory ideas into technically viable design proposals. This balance between experimentation and practical execution reflects a key objective of the pedagogical model, which sought to integrate historical textile knowledge with contemporary design practice.

In contrast, slightly lower scores were observed in the criteria originality in approach, conceptual provocation and cognitive flexibility. Although the results still indicate positive performance, they suggest that students may have prioritised technical accuracy and faithful interpretation of the historical pattern over more radical conceptual experimentation. One possible explanation is that participants needed to dedicate considerable attention to mastering the technical aspects of both manual weaving and digital representation, which may have limited the time available for more exploratory conceptual development.

The level of agreement among the experts, measured through Kendall's coefficient of concordance ($W = 0.624$), indicates moderate to substantial consistency in the evaluation process. This result supports the reliability of the evaluation grid and suggests that the criteria derived from the principles of Edward de Bono provided a coherent framework for assessing different dimensions of creativity in design practice.

The differences observed between experts are valuable because they reflect the diversity of views on the same phenomenon. Rather than representing a limitation, this diversity adds depth to the reading of the results and underlines the importance of maintaining space for multiple interpretations within the evaluation process. It is these very differences that point the way to the refinement of the grid in the future.

The comparison between manual and digital processes revealed complementary pedagogical contributions. Manual weaving emphasised the tactile, sensory and experiential dimensions of textile creation, encouraging students to engage directly with material processes and traditional craftsmanship. In contrast, digital tools such as Adobe Illustrator and Photoshop provided greater precision, speed and flexibility, allowing students to test multiple design variations and refine visual compositions more efficiently.

Student feedback further suggests that digital tools were generally perceived as accessible and easy to use, facilitating experimentation with colour, scale and pattern variations. At the same time, manual weaving generated higher levels of emotional engagement, highlighting the importance of material interaction in

the learning process. The combination of these two approaches therefore appears particularly valuable, bringing together the expressive qualities of craft with the iterative potential of digital design technologies.

From a theoretical perspective, the findings also relate to the different modes of thinking described in the models of Edward de Bono. The strong performance in process management and reflective documentation reflects aspects associated with structured thinking and metacognitive awareness, while emotional expression corresponds to intuitive and affective dimensions of creativity. However, the comparatively lower performance in originality and conceptual provocation suggests that greater emphasis on lateral thinking strategies may be beneficial in future iterations of the exercise.

These observations indicate that creativity in fashion design education emerges from a balance between technical mastery, reflective process management and conceptual experimentation. While technical learning provides the necessary foundation for execution, pedagogical strategies that encourage risk taking and divergent thinking may help students develop greater originality in their design proposals.

The results also highlight the pedagogical potential of integrating industrial textile heritage into contemporary fashion design education. By engaging directly with historical patterns and archival materials, students were able to connect cultural heritage with contemporary creative practice, reinforcing awareness of the historical and cultural dimensions of textile design.

Nevertheless, some limitations should be acknowledged. The study involved a relatively small sample of students and relied on evaluations conducted by a limited group of experts within a specific educational context. These factors may restrict the generalisation of the findings to other design programmes or cultural contexts. The duration of the study contemplated a single semester which might limit the observation of long term pedagogical consequences.

Future research could expand this approach by applying the methodology in larger groups, introducing additional conceptual challenges to stimulate greater levels of originality, and extending the exercise towards the development of full-scale garments or textile collections. Such developments would allow further exploration of how heritage based design exercises can contribute to creative learning, cultural sustainability and innovation in fashion design education. Also it is relevant for future studies to use different pattern designs behind the houndstooth pattern.

Furthermore the pedagogical model proposed in this study contributes to discussions on cultural sustainability by reinforcing the transmission of textile knowledge rooted in the historical context of the University of Beira Interior, students are exposed to traditional textile structures, techniques and visual languages that form part of the region's industrial heritage. This process not only preserves and reactivates local know how but also encourages its reinterpretation through contemporary design practices. In this sense, the proposed methodology has the potential to support the education of a new generation of fashion designers capable of integrating cultural heritage into innovative design solutions, ensuring that heritage remains dynamically reimaged within current fashion design contexts.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

This study did not require formal ethical approval according to the guidelines of the Ethics Committee of the University of Beira Interior, as it involved anonymous surveys and student academic work conducted in an educational setting, without the collection of sensitive personal data or intervention on participants. All procedures were carried out ensuring anonymity and confidentiality.

Author contributions

The first author, LV, was responsible for the design of the exercise and for the conception, research, writing of the manuscript and proposed framework. The second author, RS, was responsible for the scientific supervision, contributed to the design of the exercise and provided continuous feedback and writing revisions during the writing process of the manuscript.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was used in the creation of this manuscript. DeepL was used to help in translating the original text from portuguese to british english, and Python was used aswell to perform the mathematical calculations.

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