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Applying Musical Structures to Digital Jacquard Weaving: A Cross-Disciplinary Model for Advanced Pattern Design Education

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ABSTRACT

This study addresses a critical challenge in textile design education: cultivating advanced proficiency in the engineering of complex patterns for digital Jacquard Weaving. Traditional curricula often fail to develop the abstract structural reasoning required for innovation in CAD/CAM-based textile production. This paper proposes and validates a novel interdisciplinary pedagogical model that leverages principles from structural music theory to enhance textile pattern design capabilities. The model's efficacy was tested in a quasi-experimental study involving 60 undergraduate textile design students. The experimental group (n = 30) received a 10-week module focused on translating musical concepts, such as rhythm and counterpoint, into complex weave structures and fabric compositions, while the control group (n = 30) followed the standard curriculum. Expert evaluation of the final Jacquard design projects—assessed for pattern complexity, originality, and technical execution—revealed that the experimental group's output was statistically superior ($p < 0.05$). The findings demonstrate that this cross-disciplinary training is an effective strategy for improving both technical and creative outputs in textile pattern engineering. This model provides a structured method for cultivating the advanced design skills required by the modern textile industry.

KEYWORDS

textile education, pattern design, jacquard weaving, CAD/CAM, interdisciplinary pedagogy

INTRODUCTION

The global textile industry has undergone a profound transformation in the 21st century. Moving beyond its traditional role as a manufacturing-centric sector, it has evolved into a high-technology, design-driven field characterized by smart textiles, sustainable practices, and rapid innovation [1]. This paradigm shift has placed new and complex demands on the talent pipeline; the industry no longer seeks mere technicians but rather versatile professionals who can seamlessly integrate technical skills with sophisticated creative thinking [2,3]. Consequently, higher education institutions responsible for training the next generation of textile designers and engineers face the critical challenge of cultivating this hybrid skill set. Traditional pedagogical models in textile science and design have often been characterized by a siloed approach, where technical subjects, such as weave structure, fiber properties, and CAD/CAM operation, are taught separately from more conceptual courses in design theory and art history [4]. While effective in building foundational knowledge, this separation can inhibit the development of the fluid, integrative thinking required to produce truly innovative work [5].

This research addresses a persistent gap in textile pedagogy: the development of a structured, replicable method for enhancing the abstract and structural thinking that underpins advanced pattern design. While creativity is often treated as an innate or purely inspirational trait, cognitive science suggests that the ability to generate novel and complex patterns is deeply linked to an individual's capacity for abstract structural reasoning. The core proposition of this paper is that a targeted interdisciplinary intervention, drawing from the domain of music education, can serve as a powerful catalyst for developing this capacity in textile design students. Music, at its essence, is a discipline of structured patterns in time. Concepts such as rhythm, meter, harmony, counterpoint, and formal structure (e.g., sonata, fugue) provide a rich, non-visual language for understanding and manipulating intricate relationships between elements. There are profound cognitive parallels between the perception and creation of auditory structures in music and visual structures in textile design. The repetition and variation in a rhythmic motif mirror the development of a repeat unit in a print; the layering of melodic lines in counterpoint is analogous to the interplay of different weave structures in a complex Jacquard fabric.

This paper presents an exploratory study of an interdisciplinary educational model designed to leverage these cognitive synergies. The model integrates specific modules from music theory and composition directly into the textile pattern design curriculum. The primary research objective is to empirically assess whether this integrated approach leads to a measurable improvement in students' creative and technical proficiency compared to a traditional curriculum. By focusing specifically on the translation of musical rhythm and structure into digital Jacquard weave designs, the study aims to provide concrete, data-driven evidence for the efficacy of this pedagogical innovation. The hypothesis is that students exposed to this interdisciplinary training will not only produce designs of greater complexity and originality but will also exhibit a deeper understanding of the technical parameters of their execution. Ultimately, this research seeks to contribute a scientifically grounded and practically applicable model for talent cultivation, one that can help educational institutions better equip their students with the forward-thinking skills required to lead and innovate in the modern textile industry.

LITERATURE REVIEW

The Evolving Demands of the Textile Industry and Challenges in Education

The contemporary textile industry is increasingly defined by what is often termed “Industry 4.0,” characterized by digitalization, automation, and mass customization [6]. This shift has elevated the role of the textile designer from a creator of surface aesthetics to an architect of complex material systems. The advent of digital fabrication technologies, such as advanced Jacquard Weaving and 3D knitting, has opened up unprecedented possibilities for creating fabrics with integrated functionalities and intricate, non-repeating patterns [7]. However, leveraging these technologies effectively requires a corresponding evolution in the designer’s skill set. Industry reports consistently highlight a demand for professionals who possess not only software proficiency but also a high level of systemic and abstract thinking, enabling them to manage complexity and innovate beyond established conventions [2].

In response, textile education programs have begun to integrate more digital technology into their curricula. However, the pedagogical approach often remains focused on software operation rather than on the underlying creative and cognitive skills needed to push the boundaries of the technology [8]. This can lead to a “competency gap,” in which graduates are proficient in using the tools but lack the innovative vision to use them in novel ways. Several scholars have argued that traditional design education, with its emphasis on visual precedent and trend-following, may inadvertently stifle the kind of abstract structural thinking required for true innovation [9]. The challenge, therefore, is not simply to teach new tools but to cultivate a new way of thinking about pattern and structure itself.

Interdisciplinary Education and the Role of the Arts in STEM/STEAM

The movement toward interdisciplinary education, particularly the integration of Arts into STEM fields (creating STEAM), has gained significant traction as a potential solution to this challenge. Proponents argue that engagement with the arts can foster critical skills such as creativity, spatial reasoning, problem-solving, and systems thinking, which are highly valuable in technical and scientific domains [10]. For instance, studies have shown that integrating visual arts training can improve observational and analytical skills among medical students [11]. In engineering, design-thinking principles borrowed from the arts are used to foster a more human-centered and innovative approach to problem-solving [12].

The core premise of STEAM education is that different disciplines offer unique cognitive tools and mental models for understanding the world. By creating deliberate connections between these disciplines, educators can help students develop more flexible and powerful cognitive frameworks [13]. In the context of textile design, this suggests that integrating a non-visual, highly structured discipline like music could provide students with a novel intellectual toolkit for conceptualizing visual patterns, moving them beyond purely visual or intuitive approaches toward a more analytical and generative method of creation.

Cognitive Parallels between Musical and Visual Pattern Processing

The proposed educational model is grounded in established cognitive science research demonstrating fundamental similarities in how the human brain processes auditory and visual patterns. Both music and visual design rely on principles of Gestalt psychology, such as proximity, similarity, repetition, and figure-ground relationships, to create coherent and meaningful structures [14]. The perception of rhythm in music, for example, is not merely the recognition of a sequence of durations but an active cognitive process of grouping and organizing sounds into a hierarchical structure of beats and measures [15]. This process of hierarchical structuring is directly analogous to the way a textile designer organizes motifs into a repeat unit, and then organizes those units into a larger, coherent fabric surface.

Furthermore, neuroscientific studies have indicated overlapping neural pathways for processing complex structures, regardless of the sensory modality. For instance, research by Patel [16] supports the “shared syntactic integration resource hypothesis” (SSIRH), suggesting that music and language (and, by extension, other structured systems) draw upon the same frontal brain resources for processing complex hierarchical structures. This suggests that training in one domain—such as analyzing the contrapuntal structure of a Bach fugue—could plausibly strengthen the cognitive circuits required for designing a multi-layered Jacquard weave with intricate interdependencies. Music provides a domain in which structure and emotion are inextricably linked, offering a powerful model for how to imbue technical textile structures with aesthetic and expressive qualities [17]. This theoretical foundation provides a scientific rationale for hypothesizing that a music-integrated curriculum can directly enhance the cognitive skills central to advanced textile pattern design.

METHODOLOGY

Research Design and Participants

To empirically evaluate the effectiveness of the proposed interdisciplinary educational model, a quasi-experimental, pre-test/post-test research design was employed. This design was chosen to allow for a robust comparison between an experimental group receiving the intervention and a control group following the standard curriculum, within the practical constraints of an academic setting.

The study participants were 60 third-year undergraduate students enrolled in the Bachelor of Science in Textile Design program at a major technological university. This cohort was selected because third-year students typically possess foundational knowledge of textile principles and CAD software but have not yet completed their advanced specialization courses, making them an ideal population for this pedagogical intervention. Using a computerized random number generator, the participants were randomly assigned to one of two groups: the experimental group (n = 30; 25 female, 5 male; mean age = 20.7 years) and the control group (n = 30; 26 female, 4 male; mean age = 20.5 years). All participants provided informed consent prior to the study, and the research protocol was approved by the university's Institutional Review Board. To confirm baseline equivalence, an independent samples t-test was conducted on pre-test scores of a preliminary design task. The results confirmed that there were no statistically significant differences in pattern design skills between the experimental group (M = 5.15, SD = 1.10) and the control group (M = 5.05, SD = 1.05) prior to the intervention, $t(58) = 0.35$, $p = 0.73$.

The Intervention: Integrated Music–Textile Curriculum Module

The intervention consisted of a 10-week integrated module delivered to the experimental group for 4 hours per week, replacing a portion of their standard studio time. The control group continued with the traditional textile pattern design curriculum, which was designed to be of equivalent intensity and technical demand to the experimental module. This curriculum required students to achieve the same core outcomes—the design of structurally complex Jacquard patterns and the preparation of production-ready technical files—but utilized conventional pedagogical methods. Specifically, students were tasked with developing complex, multi-layered weave structures by drawing inspiration from the rigorous analysis of historical precedents and contemporary market trends, rather than the abstract musical concepts provided to the experimental group. Specifically, during the 4 hours per week that corresponded to the experimental group's intervention, the control group engaged in structured studio workshops of equivalent duration. These workshops were dedicated to the advanced analysis of complex historical weave structures and included guided exercises in translating intricate visual research into technically proficient, multi-layered Jacquard CAD files. This ensured that both groups dedicated the same amount of structured time to the core task of creating complex designs, with the primary difference being the pedagogical source of inspiration and structure (music vs. historical precedent).

The integrated module for the experimental group was structured as follows:

Weeks 1–3: Rhythm and Meter to Repeat Structures. This section introduced fundamental musical concepts of beat, meter (e.g., 4/4, 3/4, 6/8), and rhythmic patterns, including syncopation and polyrhythm. Students were taught to analyze rhythmic cells from musical scores and audio examples. The practical task was to translate these rhythmic structures into geometric motifs and basic repeat units using Adobe Illustrator and Photoshop. For example, a simple 4/4 beat might be translated into a four-element linear repeat, while a syncopated rhythm would be used to generate a more dynamic, offset pattern.

Weeks 4–6: Harmony and Counterpoint to Weave Interplay. This section explored musical harmony (consonance and dissonance) and counterpoint (the relationship between independent melodic lines). Students analyzed simple two-part inventions by J. S. Bach to understand how independent lines can create a cohesive whole. The corresponding textile task was to design a two-color Jacquard weave in which the interplay between warp and weft structures mimicked the contrapuntal relationship. The concept of harmonic tension and release was used as a metaphor to guide color and texture choices, creating visual tension and harmony.

Weeks 7–10: Musical Form to Complex Fabric Composition. The final section focused on larger musical forms, such as theme and variations and fugue. Students learned how a simple musical theme can be developed, inverted, and fragmented to create a complex composition. This principle was directly applied to a final project: designing a large-scale (150 cm × 150 cm) Jacquard fabric for an upholstery application. Students were required to develop a primary visual “theme” (motif) and then apply techniques of variation, fragmentation, and layering to create a complex, non-repetitive, yet structurally coherent overall design, which was then programmed using specialized Jacquard CAD software.

Data Collection and Evaluation Metrics

The primary data for this study were the final design projects completed by all 60 participants. The project brief was identical for both groups: “Design a complex Jacquard weave pattern for a high-end commercial upholstery application, providing a complete technical file ready for production.”

It is important to note that the panel was selected specifically for their deep expertise in textile design and production, not for musical literacy. The evaluation was designed to measure the *effect* of the pedagogical intervention on the final textile output, not the *fidelity* of the students’ translation from musical concepts. Therefore, the reviewers assessed the final designs on their own merits against established industry metrics (complexity, originality, technical execution), treating the musical source as a generative tool for the student rather than a blueprint to be audited. The projects, stripped of any identifying information, were assessed by a panel of three external expert reviewers (two senior textile designers from industry and one textile professor from another university). To prevent rater bias, this process was conducted under blind conditions. All 60 projects were numerically coded, and the list linking codes to group assignments was held by a third party not involved in the evaluation. The expert reviewers were therefore blind to both the students’ identities and their group affiliation (experimental or control). Furthermore, the complete set of coded projects was presented to each reviewer in a randomized order. The reviewers scored each project on a 10-point scale across three key metrics:

Pattern Complexity: This metric assessed the intricacy and sophistication of the design’s structure. It was evaluated based on the number of unique weave structures employed, the intricacy of motif development, and the successful integration of multiple design elements into a cohesive whole (1 = Very simple, single repeating element; 10 = Highly complex, multi-layered, generative structure).

Originality: This metric evaluated the novelty and creativity of the design concept and its visual expression, assessing its departure from conventional textile solutions, regardless of its musical source. It considered the uniqueness of the motif, the innovative use of color and texture, and the overall departure from conventional design solutions (1 = Highly derivative, generic; 10 = Highly original, innovative, and conceptually strong).

Technical Execution: This metric measured the technical quality and production-readiness of the submitted digital file. It assessed the cleanness of the CAD file, the correct application of weave structures, and the overall feasibility of the design for digital Jacquard weaving (1 = Unfeasible, numerous technical errors; 10 = Flawless, production-ready).

In addition to the project scores, a post-intervention survey was administered to all participants. The survey used a 5-point Likert scale to measure self-reported levels of creative confidence, engagement with the design process, and perceived improvement in problem-solving skills.

Data Analysis

The quantitative data from the expert evaluations were analyzed using IBM SPSS Statistics (Version 28). Inter-rater reliability for the expert scores was calculated using the intraclass correlation coefficient (ICC), which showed a high degree of agreement (ICC = 0.89). An independent samples t-test was conducted for each of the three evaluation metrics (complexity, originality, technical execution) to compare the mean scores of the experimental group and the control group. The significance level (alpha) was set at $\alpha = 0.05$. The quantitative data from the Likert scale survey were analyzed by comparing the mean scores for each item between the two groups.

RESULTS

The analysis of the data collected from the expert panel evaluations and the student surveys revealed statistically significant differences between the experimental group and the control group. The results support the hypothesis that the integrated music–textile curriculum positively impacted students' design proficiency.

Expert Evaluation of Final Projects

The primary outcome of the study was the scores assigned to the final Jacquard design projects. As shown in Table 1, the experimental group, which received the music-integrated intervention, achieved higher mean scores across all three evaluation metrics compared to the control group.

Table 1. Comparison of Mean Scores for Final Design Projects, Mean (SD)

Evaluation Metric	Experimental Group (n = 30)	Control Group (n = 30)	t-value	*p*-value
Pattern Complexity	8.12 (0.91)	6.45 (1.05)	6.78	< 0.001
Originality	7.95 (1.15)	6.20 (1.21)	5.89	< 0.001
Technical Execution	8.55 (0.88)	7.30 (0.95)	5.42	< 0.001

Note: Scores are on a 10-point scale. SD = Standard Deviation. The significance level is $p < 0.05$.

The results of the independent samples t-tests were significant for all three metrics. For pattern complexity, the experimental group (M = 8.12, SD = 0.91) scored significantly higher than the control group (M = 6.45, SD = 1.05), with $t(58) = 6.78$, $p < 0.001$. This indicates that the designs produced by the experimental group were judged to be more structurally intricate and sophisticated. For originality, the experimental group (M = 7.95, SD = 1.15) also significantly outperformed the control group (M = 6.20, SD = 1.21), with $t(58) = 5.89$, $p < 0.001$, suggesting their concepts and visual outcomes were more novel. Finally, in technical execution, the experimental group (M = 8.55, SD = 0.88) scored significantly higher than the control group (M = 7.30, SD = 0.95), with $t(58) = 5.42$, $p < 0.001$, demonstrating a superior ability to prepare production-ready digital files. A visual representation of these differences is provided in Figure 1, which clearly illustrates the performance gap between the two groups across all evaluated criteria.

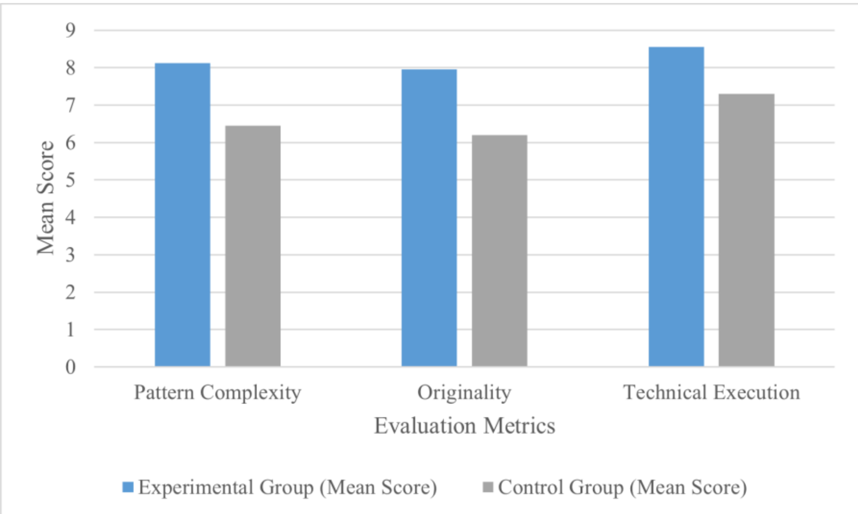

Figure 1. Bar Chart of Mean Expert Evaluation Scores

Student Self-Reported Outcomes

The post-intervention survey results corroborated the findings from the project evaluations. Students in the experimental group reported higher levels of agreement with statements related to creative growth and engagement. Table 2 summarizes the mean responses to key survey items.

Table 2. Mean Scores from Post-Intervention Student Survey (5-point Likert Scale), Mean (SD)

Survey Statement	Experimental Group (n = 30)	Control Group (n = 30)	t-value	*p*-value
I feel more confident in my ability to create complex patterns	4.65 (0.48)	3.55 (0.60)	8.08	< 0.001
The curriculum helped me think about design in a new way	4.78 (0.42)	3.10 (0.75)	11.00	< 0.001
I felt highly engaged throughout the final design project	4.50 (0.51)	3.80 (0.65)	4.67	< 0.001

Note: 1 = Strongly Disagree, 5 = Strongly Agree. Significance level is $p < 0.05$.

The data show a notable difference in perception between the groups. Independent samples t-tests confirmed that these differences were statistically significant. The experimental group reported significantly higher confidence in their ability to create complex patterns (M = 4.65, SD = 0.48) compared to the control group (M = 3.55, SD = 0.60), with $t(58) = 8.08$, $p < 0.001$. Similarly, they more strongly agreed that the curriculum helped them think about design in a new way (M = 4.78, SD = 0.42) than their control-group peers (M = 3.10, SD = 0.75), $t(58) = 11.00$, $p < 0.001$. These findings strongly suggest that the intervention not only improved their objective performance but also positively and significantly influenced their creative self-efficacy and metacognitive awareness of the design process.

DISCUSSION

The results of this study provide strong empirical support for the integration of music education principles into the textile design curriculum as a means of enhancing both creative and technical proficiency. The statistically significant outperformance of the experimental group across all three metrics—pattern complexity, originality, and technical execution—suggests that the intervention was not merely an ancillary creative exercise but a potent pedagogical tool that fundamentally improved students' core design capabilities. The discussion will now interpret these findings in the context of the established literature, explore the implications for textile education, and acknowledge the limitations of the current study.

The marked improvement in pattern complexity among students in the experimental group can be directly linked to the cognitive scaffolding provided by the musical concepts. The traditional approach to pattern design often relies on visual intuition and the manipulation of motifs within a grid. In contrast, the music-integrated module provided students with an abstract, rule-based system for generating and developing patterns. By learning to think in terms of rhythm, counterpoint, and formal development, students were equipped with a generative grammar for design. For example, the task of translating a polyrhythm into a visual pattern forced students to move beyond simple linear repetition and engage with the more complex idea of simultaneous, interlocking structures. This aligns with the work of Root-Bernstein & Root-Bernstein [18] on the importance of "tools for thinking" derived from different disciplines. Music, in this context, did not provide the visual content of the design but rather a sophisticated structural logic for organizing that content, leading to the measurably more complex outcomes observed.

The significant increase in originality is perhaps the most compelling finding. A common challenge in design education is encouraging students to break away from familiar visual tropes and trends. The intervention addressed this by shifting the inspirational source from the visual domain to the auditory one. This cross-modal translation process inherently fostered abstraction. Students could not simply copy a musical score; they had to interpret its underlying structure and dynamics and then invent a visual language to represent it. This act of translation is a powerful creative catalyst, forcing the designer to make novel connections and invent new forms. This finding supports the broader theory of STEAM education, which posits that innovation often occurs at the intersection of disciplines. By bridging the sensory and intellectual gap between music and textiles, the curriculum prompted a more profound and original mode of creative inquiry. A central cognitive challenge inherent in this pedagogical model is the translation of music's fundamentally temporal structure into the spatial and static medium of a textile. The study's findings suggest that students navigated this challenge not through literal transcription, but through a process of abstraction and metaphor. For sequential musical concepts like rhythm and meter, students mapped the temporal axis onto a spatial one—for instance, a sequence of notes in time became a linear progression of motifs in the design. However, the most powerful translations appeared to emerge from musical concepts that already contain a high degree of simultaneous complexity. Counterpoint, with its interplay of independent melodic lines woven together at a single moment in time, provides a direct conceptual analogue to the layered, interlocking structure of warp and weft threads in a Jacquard fabric. This act of translating the successive nature of music into the simultaneous reality of cloth forced students to deconstruct musical ideas into their core structural relationships and then invent a novel visual system to represent them, a process which likely fueled the observed gains in both complexity and originality.

Furthermore, the unexpected but significant improvement in technical execution highlights a key benefit of this interdisciplinary model. The abstract, logical nature of musical structures appears to have enhanced the students' systematic thinking, which translated directly to the meticulous process of programming a Jacquard weave. It is a valid consideration whether this improvement stems from the abstract nature of the musical intervention itself, or simply from the intensive focus on complex, multi-layered structures (e.g., counterpoint exercises) compared to the standard curriculum. However, while the control group also engaged in creating complex designs based on visual precedents, the experimental group was tasked with applying a novel, rule-based conceptual framework. Unlike a purely visual approach, musical concepts such as counterpoint provided students with a non-visual, formal logic for organizing independent yet interlocking layers. This process appears to have fostered a more robust and abstract form of systematic thinking that is directly analogous to the logical challenges of CAD programming, moving beyond the specific outcomes of visually derived exercises alone. Designing a contrapuntal structure in a weave file requires careful planning of how different layers of threads interact, a process that is cognitively analogous to arranging independent melodic lines in a musical composition. The music module, by training students in this form of systematic, multi-layered thinking, may have inadvertently improved their ability to manage the technical complexity of the CAD software.

Furthermore, the unexpected but significant improvement in technical execution highlights a key benefit of this interdisciplinary model. We propose that the cognitive link between musical analysis and enhanced CAD proficiency, specifically "file cleanness," operates on two levels. First, the meticulous, rule-based nature of analyzing harmony and counterpoint cultivates a high degree of precision and attention to detail. In a musical composition, a single misplaced note can create unintended dissonance, disrupting the entire structure; this practice of systematic error-checking is directly analogous to debugging a complex CAD file, where a single incorrect weave assignment can create a production flaw. Second, structuring a complex piece like a fugue requires hierarchical planning and the management of multiple, independent-yet-interrelated layers. This cognitive skill of organizing interlocking systems appears to be highly transferable to the task of programming a Jacquard file, leading to more logically structured layers, fewer programming errors, and a technically cleaner, production-ready output. This suggests that the model does not create a trade-off between creativity and technical skill, but rather demonstrates that a deep, structural approach to creativity can directly reinforce technical excellence.

The implications for textile education are substantial. This study presents a viable, evidence-based alternative to the often nebulous methods used to teach “creativity.” It proposes that creativity in pattern design can be systematically cultivated through structured, cross-disciplinary training that targets the underlying cognitive skills of pattern recognition and structural manipulation. Curricula could be redesigned to include modules that explicitly train students in abstract systems thinking, using domains like music, mathematics, or even linguistics as pedagogical tools. This approach could help produce graduates who are not only skilled technicians but also versatile innovators capable of adapting to the rapidly changing technological landscape of the textile industry.

Despite the promising results, this study has several limitations that must be acknowledged. The sample size of 60 students, while sufficient for statistical analysis, is relatively small and was drawn from a single institution, which significantly limits the generalizability of the findings. Furthermore, the sample exhibited a significant gender imbalance, with the vast majority of participants being female. While this ratio is broadly representative of the demographics within the textile design field, it is a limitation that may affect the generalizability of the findings to populations with a more balanced gender distribution. Future research should explore whether these pedagogical benefits observed in a predominantly female cohort are equally effective in other disciplinary contexts. It is crucial to acknowledge that the positive outcomes observed may have been heavily influenced by contextual factors unique to this study, such as the specific departmental culture, the instructors’ enthusiasm for a novel curriculum, or the pre-existing aptitude of this particular student cohort. Therefore, the results should be interpreted as a promising but preliminary proof of concept rather than a universally applicable conclusion. The 10-week duration of the intervention, while intensive, is also relatively short. Consequently, while the study effectively demonstrates a short-term performance boost, it does not address the critical question of long-term cognitive transfer. It remains an open question whether students will retain and independently apply this abstract, music-driven structural thinking once the specialized module concludes, or if they will revert to more conventional design paradigms. The ultimate validation of this interdisciplinary approach hinges on its ability to create lasting change in a student's cognitive toolkit. A longitudinal study that follows students throughout their academic careers and into their professional lives would be necessary to determine the long-term impact of this pedagogical approach. Future research should aim to replicate this study with larger and more diverse student populations. Additionally, future investigations could explore the effects of different musical genres or concepts (e.g., microtonal music, algorithmic composition) on textile design outcomes, or apply this cross-disciplinary model to other areas of textile education, such as material science or fashion construction.

CONCLUSION

This research set out to explore an innovative interdisciplinary educational model designed to address the evolving talent requirements of the modern textile industry. By systematically integrating principles of musical rhythm, harmony, and structure into the textile pattern design curriculum, the study sought to determine if such an approach could yield measurable improvements in students' creative and technical abilities. The quasi-experimental study provided compelling, data-driven evidence in support of this model. The students who participated in the music-integrated curriculum produced final Jacquard designs that were judged by independent experts to be significantly more complex, original, and technically well-executed than those produced by their peers in a traditional curriculum.

The findings strongly suggest that the cognitive skills honed through the analysis and application of musical structures are transferable to the visual and technical domain of textile design. The model proved effective not merely as a source of novel inspiration but as a rigorous method for training the abstract, structural, and systematic thinking that underpins true innovation in the field. This research contributes to the broader discourse on STEAM education by providing a specific, replicable, and empirically validated case study of how arts integration can directly enhance technical and engineering-related competencies. The conclusion drawn is that the strategic fusion of music education and textile design is not a peripheral enhancement but a core pedagogical strategy that can cultivate more capable, confident, and innovative designers. As the textile industry continues its trajectory toward greater complexity and digitalization, such interdisciplinary educational models will be essential in preparing a new generation of talent equipped not just to participate in the industry but to lead its creative and technological advancement.

Author Contributions

Yushi Lin designed, collected and analyzed the data, and drafted the manuscript. Yushi Lin conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Yushi Lin participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest

The author declares no conflict of interest.

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Ethics Approval and Consent to Participate

This survey was conducted in compliance with Ethics Committee of Normal College of Jimei University. Participants were informed of the study's purpose and data usage prior to participation, and responses were collected anonymously. No personally identifiable information was stored.

Availability of Data and Materials

The datasets used and/or analysed during the current study were available from the corresponding author on reasonable request.

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Not applicable.

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