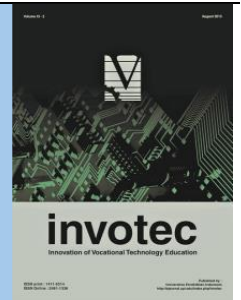




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LEARNING STYLES AND STUDENT PERFORMANCE IN WOMEN'S WEAR COURSE: A MULTIVARIATE APPROACH

Putu Diah Ari Kusumadewi^{1*}, Raden Rosnawati²

¹Fashion Education, Faculty of Engineering, Universitas Negeri Yogyakarta, Indonesia

²Educational Research and Evaluation, Graduate School, Universitas Negeri Yogyakarta, Indonesia

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Authors email:

putudiaharikusumadewi@uny.ac.id

ABSTRACT

Understanding how students' learning styles influence their academic performance is essential in optimizing instruction, particularly in vocational fields like fashion education. This study examines the impact of visual, auditory, and kinesthetic learning styles on students' creativity, garment construction, and technical proficiency in women's wear course. A quantitative, cross-sectional design was adopted, involving 70 fashion students from Universitas Negeri Yogyakarta. Data on students' learning preferences were collected using a validated 21-item VAK-based questionnaire. K-means cluster analysis was applied to categorize students into three learning style clusters. Subsequently, a one-way multivariate analysis of variance (MANOVA) was conducted to assess the effect of learning style clusters on learning outcomes. The analysis revealed significant multivariate effects of learning styles on the combined outcomes (Pillai's Trace = 0.923, $F(6, 132) = 18.87$, $p < .001$). Univariate ANOVAs and post hoc tests indicated that students in the auditory-dominant cluster consistently outperformed those in the visual- and kinesthetic-oriented clusters across all outcome dimensions. These findings highlight the importance of aligning teaching strategies with diverse learning styles to ensure equitable learning experiences in creative disciplines. The results also provide practical guidance for curriculum designers in vocational fashion education to develop multimodal learning environments that balance auditory, visual, and kinesthetic engagement, thereby enhancing learning inclusivity and effectiveness.

1. Introduction

Fashion education plays a pivotal role in preparing students for careers in the global fashion industry by developing both technical and creative skills. As a form of vocational training, it emphasizes hands-on learning in garment design and construction. Within this context, understanding how students process and engage with instructional content, through their individual learning styles, is essential for optimizing educational strategies and outcomes (Jiang et al., 2024).

Prior research suggests that fashion students exhibit distinct learning style preferences. For instance, merchandising students tend to favor active, sensing, visual, and sequential styles (Crutsinger et al., 2005). Aligning instructional methods with such preferences has been shown to improve academic performance and engagement, particularly for students who may not thrive in conventional educational settings (Rahal & Palfreyman, 2009). However, most of these studies have focused on general learning behavior rather than on how learning styles specifically influence

performance in fashion practice courses. This highlights a need to explore how modality preferences affect both creative and technical outcomes in fashion education.

Visual, auditory, and kinesthetic learning styles are especially relevant in fashion education, which involves creative and practical learning activities (Marín-Tello et al., 2022; Nekaris et al., 2025; Hwang et al., 2015). Cross-cultural research has revealed diverse modality preferences among fashion students. For example, Swazi students favor the print modality, whereas Korean and U.S. students lean toward interactive, visual, and kinesthetic approaches (Caldwell et al., 2005). Similarly, students in fashion programs tend to prefer kinesthetic learning, while those from other majors who enroll in fashion courses may show auditory preferences (Qiu et al., 2018). These variations underline the need for educators to understand and accommodate such diversity to support equitable learning outcomes across cultural and cognitive contexts.

Although learning styles have been widely explored in fields such as engineering (Dominguez et al., 2025), medical education (Hernández-Torrano et al., 2017), and general higher education (Alonso-Martín et al., 2021), their impact on student performance remains underexplored in the context of fashion education, particularly in women's wear instruction. While studies have shown that aligning pedagogy with students' preferred learning modalities improves comprehension and motivation (Nugraha & Budiaynto, 2022), traditional instructional practices in women's wear design often overlook these variations, potentially limiting students' development in both creative and technical competencies. Therefore, bridging this gap is crucial to advancing pedagogical approaches in vocational fashion programs.

Accordingly, this study investigates how learning styles influence student performance in a women's wear course. By applying a multivariate statistical approach that integrates K-means clustering and MANOVA, the study seeks to reveal how different modality preferences relate to students' creative and technical achievements. Specifically, this study seeks to answer the following research questions: 1) How do visual, auditory, and kinesthetic learning styles influence students' design creativity, garment construction, and technical skills in a women's wear course? 2) Which learning style cluster demonstrates the highest performance across these outcome dimensions? To strengthen the empirical foundation of this inquiry, the following hypotheses were formulated:

H_0 (null) : There are no statistically significant multivariate differences in the combined learning outcomes (Design Creativity, Garment Construction, and Technical Skills) among the learning style clusters.

H_1 (alternative) : There are statistically significant multivariate differences in the combined learning outcomes among the learning style clusters

Addressing these questions contributes to the growing body of literature on learning personalization and provides pedagogical insights for curriculum designers in vocational fashion education.

2. Method

1.1 Research Design

This study employed a quantitative, cross-sectional research design to investigate the relationship between fashion students' learning styles—visual, auditory, and kinesthetic—and their learning outcomes in women's wear course. A multivariate approach was adopted, integrating cluster analysis and multivariate analysis of variance (MANOVA). Cluster analysis was used to categorize students based on their learning style profiles, while MANOVA examined the differences in learning outcomes across the resulting clusters. This design allowed for the simultaneous analysis of multiple learning outcomes and their association with learning style categories.

1.2 Data Collection

1.2.1 Learning Styles Questionnaire

Students' learning preferences were measured using a 21-item questionnaire based on the Visual, Auditory, and Kinesthetic (VAK) model. The instrument was theoretically grounded in Gardner's Multiple Intelligences Theory (GMIT) (Phillips, 2010) and Kolb's Experiential Learning Theory (KELT) (Kolb et al., 2014), which both emphasize the diversity of cognitive modalities and experiential engagement in learning. These two frameworks collectively support the VAK model by providing a conceptual basis for categorizing how learners perceive, process, and internalize information through visual, auditory, or kinesthetic channels.

The instrument measured students' preferences for different learning modalities, categorized into three main domains: visual, auditory, and kinesthetic (Table 1). Each item was rated on a 5-point Likert scale ranging from 1 (Never) to 5 (Always).

Table 1. Blueprint of Learning Styles Questionnaire

Learning Style	Indicator	Sub-Indicator	Item Number
Visual	Preference for visual input	Use of diagrams, charts, images, and written text for learning	1-4
		Preference for written instructions over verbal explanations	5
	Memory retention	Ability to recall information presented visually	6
	Engagement in visual activities	Preference for watching instructional videos or presentations	7
Auditory	Preference for sound-based input	Learning best through lectures, discussions, and listening	8-10
		Enjoyment of listening to podcasts or recorded materials	11-12
	Memory retention	Ability to recall information better when heard	13
	Engagement in auditory activities	Preference for discussing concepts or explaining material aloud	14-15
Kinesthetic	Preference for hands-on experience	Learning best through physical tasks or experiments	16
		Engagement in physical activities like role-playing or building models	17-18
	Memory retention	Ability to remember information better when physically engaged	19-20
	Engagement in hands-on activities	Engagement in hands-on activities	21

The questionnaire included 7 items for visual learning, 8 items for auditory learning, and 6 items for kinesthetic learning. Content validity was assessed using Aiken's V, with all items (21 items) scoring above 0.70, indicating strong expert agreement. Internal consistency was evaluated using Cronbach's alpha, with high reliability coefficients:

- Visual: $\alpha = 0.85$
- Auditory: $\alpha = 0.98$
- Kinesthetic: $\alpha = 0.89$

These results confirm the questionnaire's strong internal consistency within each learning style category.

1.2.2 Learning Outcomes Assessment

Students' learning outcomes were assessed through final projects in a women's wear course. These projects were evaluated using an instructor-developed rubric focusing on three domains:

- Design Creativity (DC): Innovation and originality in design concept
- Garment Construction (GC): Technical precision, sewing quality, and finishing
- Technical Skills (TC): Mastery of fabrics, pattern-making, and sewing techniques

Each domain was rated on a 5-point scale, and the average of the three scores represented the student's overall learning performance. Evaluations were conducted at the end of the semester and reflected authentic assessment of practical fashion competencies.

1.3 Sample Selection

The participants included 70 undergraduate students enrolled in a women's wear course at Universitas Negeri Yogyakarta. Total sampling was used, as the entire cohort was involved in the study. The sample size was adequate for multivariate analysis and allowed for robust comparisons across learning style clusters.

1.4 Data Analysis Methods

1.4.1 Cluster Analysis

K-means clustering was applied to the standardized learning style scores to group students based on their dominant modality preferences. The number of clusters ($K = 3$) was determined in accordance with the three predefined learning styles (visual, auditory, kinesthetic). The Elbow Method was employed to confirm the appropriateness of $K = 3$ by evaluating the within-cluster sum of squares. The resulting cluster groups were then used as the independent variable in subsequent MANOVA analysis.

1.4.2 Multivariate Analysis

MANOVA was conducted to determine whether significant differences existed among the three cluster groups in terms of their performance in women's wear course. The three dependent variables were Design Creativity, Garment Construction, and Technical Skills. The assumptions of normality and homogeneity of covariance matrices were tested prior to analysis. Pillai's Trace was selected as the test statistic due to its robustness against violations of multivariate assumptions. Data analysis was conducted using R, which provides appropriate tools for both clustering and MANOVA. The hypotheses tested were:

- H_0 (null) : There are no statistically significant multivariate differences in the combined learning outcomes (Design Creativity, Garment Construction, and Technical Skills) among the learning style clusters.
- H_1 (alternative) : There are statistically significant multivariate differences in the combined learning outcomes among the learning style clusters

1.5 Research Ethics

All research procedures complied with the ethical principles of voluntary participation, informed consent, and confidentiality. Participation in this study was entirely voluntary, and informed consent was obtained from all participants prior to data collection. Students were assured that their responses would remain confidential and used solely for academic research purposes.

This research implements a quantitative descriptive method, an approach used to systematically describe and analyze phenomena or characteristics of populations and samples (Creswell & Creswell, 2018). This methodology emphasizes quantitative data collection through measurement instruments such as surveys (Fraenkel et al., 2019). The research location includes several Vocational High Schools that have expertise programs in Automotive Light Vehicle Engineering (TKRO), Motorcycle Engineering and Business (TBSM), Heavy Vehicle Engineering (TKB), Automotive Body Technology (TBO), and Autotronics Technology (TOT) in several regions of West Java. The research population consisted of 48 Automotive Productive Teachers who were alumni of the Mechanical Engineering Education Study Program at the University of Education Indonesia (UPI). This study used a census approach involving all Automotive Productive Teachers from the UPI Mechanical Engineering Education Study Program of 48 people, which represented the total population (Nanjundeswaraswamy & Divakar, 2021). Data analysis uses a simple correlation coefficient test and a simple regression test with a prerequisite analysis or classical assumption test which includes normality test, linearity test, and heteroscedasticity test.

3. Results and Discussion

This study investigated the impact of fashion students' learning styles on their performance in women's wear design by employing K-means cluster analysis followed by a multivariate analysis of variance (MANOVA). The goal was to identify whether distinct learning style profiles (visual, auditory, kinesthetic) were associated with differences in students' creativity, garment construction, and technical skills.

1.6 Cluster Analysis of Learning Styles

K-means cluster analysis was conducted to categorize students based on their dominant learning styles—visual, auditory, and kinesthetic. The number of clusters was set to $K = 3$ in alignment with the theoretical framework of the three primary sensory modalities. The optimal number of clusters was confirmed using the Elbow Method, which showed a distinct inflection at $K = 3$, indicating that a three-cluster solution provided the best balance between simplicity and explanatory power (Figure 1).

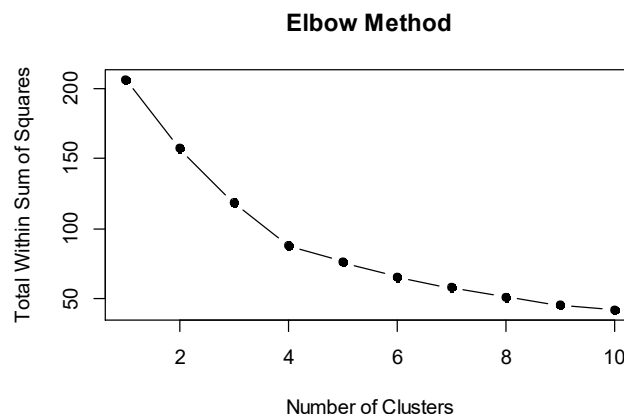


Figure 1. Elbow Curve for K-Means Clustering

The Elbow curve shows the within-cluster sum of squares (WCSS) across different values of K . A sharp bend at $K = 3$ suggests that three clusters best represent the data distribution. Cluster analysis identified three distinct learning style profiles (Table 2). Cluster 1 represented auditory-dominant students, Cluster 2 visual-dominant students, and Cluster 3 kinesthetic-oriented students. The distribution of these clusters across visual and auditory dimensions is illustrated in Figure 2, which shows clear group separation corresponding to auditory-, visual-, and kinesthetic-oriented profiles.

Table 2. Mean Learning Style Scores by Cluster

Cluster	Visual Mean	Auditory Mean	Kinesthetic Mean	Dominant-Style
1	2.98	3.56	3.39	Auditory-Dominant
2	3.35	3.03	2.60	Visual-Dominant
3	2.55	2.56	3.06	Kinesthetic-Oriented

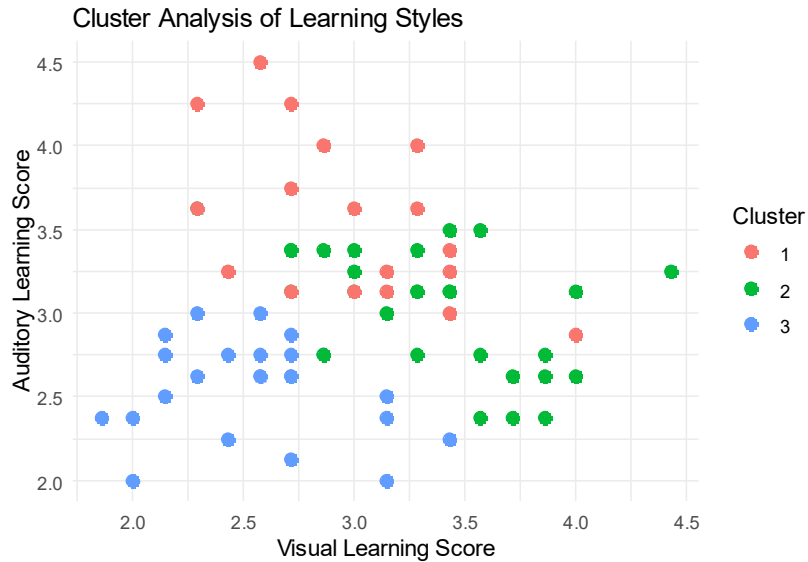


Figure 2. Scatterplot of Student Learning Style Clusters

Scatterplot of students’ standardized scores on visual and auditory dimensions, with color-coded cluster membership determined by K-means algorithm. The plot shows clear group separation corresponding to auditory-, visual-, and kinesthetic-oriented profiles. These clusters served as the independent grouping variable in the subsequent multivariate analysis of variance (MANOVA), to determine whether students’ learning style profiles were associated with differences in their learning outcomes in women’s wear course. This clustering result reinforces prior findings that students in vocational and creative disciplines such as fashion tend to display differentiated learning preferences (Qiu et al., 2018). The prominence of auditory dominance in Cluster 1 may reflect contextual characteristics of the instructional approach used in the program, where verbal explanations, demonstrations, and feedback from instructors are frequent and influential in shaping learning behavior. Research indicates that auditory learning styles may be associated with lower levels of engagement compared to other styles like visual and kinesthetic (Nekaris et al., 2025). This could imply that purely auditory methods might not be the most effective for maintaining student interest and participation in fashion education. Hence, the identification of this cluster structure offers meaningful insight for tailoring instructional strategies, suggesting a need to rebalance learning environments toward more multimodal and experiential engagements to better serve diverse learners

1.7 Multivariate

A one-way multivariate analysis of variance (MANOVA) was conducted to examine whether students’ learning style clusters had a statistically significant effect on their performance in the women’s wear course. The three dependent variables were Design Creativity (DC), Garment Construction (GC), and Technical Skills (TS), while the independent variable was cluster membership (auditory, visual, and kinesthetic-dominant).

Prior to analysis, assumptions of multivariate normality and homogeneity of covariance matrices were tested. Although Shapiro–Wilk and Box’s M tests indicated minor violations, the

MANOVA procedure was considered robust under the present sample conditions. Therefore, Pillai's Trace was used as the test statistic due to its robustness to assumption violations. Results revealed a significant multivariate effect of learning style clusters on the combined dependent variables, $V = 0.923$, $F(6, 132) = 18.87$, $p < .001$, indicating that students' overall learning performance differed significantly across clusters. Follow-up univariate ANOVAs confirmed significant between-group differences for all three learning outcomes (Table 3).

Table 3. Univariate ANOVA Results

Learning Outcome	F(2, 67)	<i>p-value</i>
Design Creativity (DC)	253.42	< .001
Garment Construction (GC)	217.43	< .001
Technical Skills (TS)	225.04	< .001

Post hoc Tukey's HSD tests revealed that students in the auditory-dominant cluster (Cluster 1) achieved significantly higher scores across all outcome dimensions than those in the visual- and kinesthetic-oriented clusters ($p < .001$). Mean scores are summarized in Table 4.

Table 4. Mean Scores of Learning Outcomes by Cluster

Cluster	Design Creativity	<i>Garment Construction</i>	<i>Technical Skills</i>
1	4.93	4.92	4.92
2	3.94	3.95	3.94
3	4.13	4.13	4.17

Overall, the MANOVA results demonstrate that learning style clusters significantly influenced student performance in the women's wear course, with auditory-dominant learners performing best, followed by kinesthetic-oriented and visual-dominant learners. These pedagogical elements align more with real-time, process-based engagement than with static visual input (Brucker et al., 2014; Castro-Alonso et al., 2015)). Meanwhile, kinesthetic learners, although not the top performers, still outperformed visual-dominant learners, highlighting the critical role of tactile, experiential strategies in fashion learning environments.

The relatively lower performance of visual-dominant students may reflect a misalignment between the course delivery and their cognitive preferences, particularly if visual scaffolding such as diagrams, annotated visuals, or visual storytelling was underutilized. This observation is consistent with prior findings by Marín-Tello and Hwang et al., which emphasize the detrimental effects of modality mismatch on student engagement and learning outcomes (Marín-Tello et al., 2022; (Hwang et al., 2015)). These results underscore the importance of integrating richer visual scaffolding, such as annotated video tutorials, visual process maps, and layered pattern breakdowns, especially to support students whose strengths lie in visual processing. Mayer's Cognitive Theory of Multimedia Learning posits that learning is optimized when visual and auditory channels are effectively balanced, thus preventing overload in any single modality (Mayer, 2024). This supports the argument that multimodal instructional designs may offer a more equitable and effective learning environment for diverse learners.

Although auditory learners thrived under the current instructional model, this raises broader concerns regarding equity in instructional design. Future research may explore targeted interventions that adapt teaching strategies to support underperforming visual learners, including experimental comparisons of different multimodal strategies in fashion education contexts.

4. Conclusion

This study investigated the relationship between students' learning style clusters and their performance in women's wear course. Using K-means clustering, students were categorized into three distinct groups, auditory-dominant, visual-dominant, and kinesthetic-oriented, based on their responses to a validated VAK learning styles questionnaire. The subsequent MANOVA analysis revealed a statistically significant effect of learning style clusters on students' outcomes in design creativity, garment construction, and technical skills. Auditory-dominant learners demonstrated the highest performance across all dimensions, followed by kinesthetic-oriented students, while visual-dominant learners consistently scored lowest.

These findings suggest that instructional formats commonly used in fashion education such as verbal demonstrations, real-time feedback, and hands-on practice may be particularly beneficial for auditory and kinesthetic learners. Conversely, visual learners may be disadvantaged when teaching approaches underutilize visual scaffolds like diagrams, visual process mapping, and multimedia instruction. The study highlights the importance of aligning teaching strategies with diverse learning preferences to enhance learning equity and optimize educational outcomes.

In light of these results, fashion educators are encouraged to adopt multimodal instructional designs that accommodate various learning styles. Integrating rich visual materials alongside auditory and kinesthetic components can support more inclusive learning environments. Nevertheless, this study is limited by its relatively small sample size and focus on a single institutional context, which may affect the generalizability of the findings. Future research should therefore involve larger and more diverse samples across different vocational fashion programs and investigate the long-term effects of adaptive, multimodal teaching interventions. Despite these limitations, the study contributes valuable insights to the field of fashion pedagogy by demonstrating how aligning instructional modes with diverse learning preferences can enhance creativity and technical competence in vocational education.

Conflicts of Interest

The authors declare no conflict of interest regarding the publication of the paper.

References

- Alonso-Martín, P., Cruz-Díaz, R., Granado-Alcón, C., Lago-Urbano, R., & Martínez-García, C. (2021). Variability of higher education students' learning styles depending on gender, course, degree and institutional context. *Sustainability (Switzerland)*, *13*(4), 1–18.
- Brucker, B., Scheiter, K., & Gerjets, P. (2014). Learning with dynamic and static visualizations: Realistic details only benefit learners with high visuospatial abilities. *Computers in Human Behavior*, *36*, 330–339.
- Caldwell, L. F., Workman, J. E., Lee, S. H., & Khoza, L. (2005). An analysis of cross-cultural differences in perceptual modality preferences of fashion design and merchandising students from South Korea, Swaziland, and the United States. *Clothing and Textiles Research Journal*, *23*(4), 350–359.
- Castro-Alonso, J. C., Ayres, P., & Paas, F. (2015). The Potential of Embodied Cognition to Improve STEAM Instructional Dynamic Visualizations. *Emerging Technologies for STEAM Education*, 113–136.
- Crutsinger, C. A., Knight, D. K., & Kinley, T. (2005). Learning style preferences: Implications for web-based instruction. *Clothing and Textiles Research Journal*, *23*(4), 266–277.
- Dominguez, L. G. I., Robles-Gomez, A., & Pastor-Vargas, R. (2025). A data-driven approach to engineering instruction: exploring learning styles, study habits, and machine learning. *IEEE Access*.

- Hernández-Torrano, D., Ali, S., & Chan, C. K. (2017). First year medical students' learning style preferences and their correlation with performance in different subjects within the medical course. *BMC Medical Education*, 17(1), 1–7.
- Hwang, G. J., Chiu, L. Y., & Chen, C. H. (2015). A contextual game-based learning approach to improving students' inquiry-based learning performance in social studies courses. *Computers & Education*, 81, 13–25.
- Jiang, Z., Islam, S., & Lyu, J. (2024). Mixed teaching pedagogy for fashion merchandising students: an exploratory investigation of flipped- and lecture-based learning in retail mathematics courses. *International Journal of Fashion Design, Technology and Education*.
- Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2014). Experiential learning theory: Previous research and new directions. *Perspectives on Thinking, Learning, and Cognitive Styles*, 227–247.
- Marín-Tello, C., Guevara-Vásquez, A. M., Amaya-Lau, L., Rafael-Manosalva, Y., Villafana-Medina, H., & Vásquez-Kool, J. (2022). A visual thinking strategy enhances an undergraduate human physiology course offered by a Peruvian Pharmacy and Biochemistry School. *Pharmacy Education*, 22(1), 647–653.
- Mayer, R. E. (2024). The Past, Present, and Future of the Cognitive Theory of Multimedia Learning. *Educational Psychology Review*, 36(1), 1–25.
- Nekaris, K. A. I., Rickets, H., Campera, M., Bukit, W. L., & Ali Imron, M. (2025). The impact of teaching method and learning style on student engagement: a formative assessment of a primate education programme. *Folia Primatologica*, 1(aop), 1–10.
- Nugraha, A. A., & Budiaynto, U. (2022). Adaptive E-Learning System Berbasis Vark Learning Style dengan Klasifikasi Materi Pembelajaran Menggunakan K-NN (K-Nearest Neighbor) . *Technomedia Journal (TMJ)*, 7(02).
- Phillips, H. (2010). Multiple Intelligences: Theory and Application. *Perspectives In Learning*, 11(1).
- Qiu, H., Saiki, D., & Adomaitis, A. D. (2018). Learning styles of students enrolled in fashion classes: academic level, geographic region, and academic focus. *International Journal of Fashion Design, Technology and Education*, 11(3), 277–286.
- Rahal, T., & Palfreyman, D. (2009). Assessing Learning Styles of Students at Zayed University. *Learning and Teaching in Higher Education: Gulf Perspectives*, 6(2), 2–35.