Environment and Social Psychology (2025) Volume 10 Issue 2 ISSN: 2424-8975 (O)
doi: 10.59429/esp.v10i2.3427 2424-7979 (P)

RESEARCH ARTICLE

Construction of an effectiveness evaluation model for furniture design curriculum reform under the new engineering education paradigm

Junfeng Wang*, Ramir Santos Austria

College of Teacher Education, University of the Cordilleras, Gov. Pack Road, Baguio City, 2600, Philippines

*** Corresponding author:** Junfeng Wang, junfengwangzi@qq.com

ABSTRACT

Purpose: This study develops and validates a comprehensive evaluation model for assessing furniture design curriculum reform effectiveness under the New Engineering Education paradigm, 6 addressing the need for systematic assessment tools in design education transformation.Methodology: The research employs a mixed-methods approach incorporating both quantitative and qualitative analysis. A hierarchical evaluation framework was constructed using analytic hierarchy process (AHP) and fuzzy comprehensive evaluation methods. Data was collected from 324 participants across 12 universities, including faculty members (n=86), students (n=198), and industry experts (n=40), over a three-year implementation period (2021-2024). Results: The evaluation model demonstrated high reliability (Cronbach's $\alpha = 0.937$) and strong predictive accuracy (MAPE = 3.2%). Statistical analysis revealed significant improvements in student performance metrics (technical competency increased from 65% to 88%) and stakeholder satisfaction (student satisfaction reached 92%, industry satisfaction 88%). Regional implementation variations were identified, with eastern regions achieving 92% implementation rates compared to northern regions at 85%. The model validation process showed strong consistency across different institutional contexts (CV = 0.089). Implications: The study provides a standardized framework for assessing curriculum reform effectiveness, enabling data-driven decision-making in educational program development. The findings offer practical guidelines for institutions implementing new engineering education reforms and valuable insights for policy makers in developing targeted support mechanisms. Limitations: Geographic concentration of the sample and the three-year implementation period may limit generalizability and long-term impact assessment. The predominantly quantitative approach may not fully capture qualitative aspects of educational outcomes.

Keywords: New engineering education; curriculum reform; furniture design; evaluation model; higher education; teaching effectiveness; industry integration; sustainable development; educational assessment; reform implementation

1. Introduction

In this rapidly developing field of engineering education, traditional teaching structures have become more and more mandatory to reform in order to solve existing problems and fulfill contemporary labor market requirements. The "New Engineering Education" concept presupposes a substantial transformation in the approach to technical training, especially in narrow fields like furniture design. Such

ARTICLE INFO
Received: 1 February 2025 | Accepted: 18 February 2025 | Available online: 28 February 2025

CITATION
Wang JF, Austria RS. Construction of an effectiveness evaluation model for furniture design curriculum reform under the new engineering education paradigm. *Environment and Social Psychology* 2025; 10(2): 3427. doi:10.59429/esp.v10i2.3427

education, in this context, is oriented toward interdisciplinary approaches, innovative potential, and the principles of sustainable development for the purpose of satisfying the complex demands of contemporary society[1].

Over the last decades, furniture design has undergone some substantial changes: this is essentially motivated by technological changes, demands for sustainability, and changes in consumer attitudes. However, traditional learning methods in furniture design are indeed necessary but cannot fully provide the competencies that a present-day professional needs[2]. The Nordic design tradition, which through history has held a leading position in furniture design education, underlines the necessity of integrating aesthetic aspects with functional requirements and sustainability[3]

The task of restructuring furniture design education in the light of the emerging engineering paradigm is a complex one for sure. This involves attention to the structure of the curriculum, methods of instruction and also mechanisms of assessment that can adequately appraise both technical competencies and creative abilities[4]. Sustainable design concepts, as rallied by the leading theorists and practitioners, have increasingly taken center-stage in the education of furniture design [9, 10]. This would be in keeping with wider environmental initiatives and circular economy principles being taken up across the European Union and globally[5].

Recent works have identified the urgent need to develop integrated assessment frameworks from an educational reform point of view, especially with regard to design-based courses[13, 14]. For that, learning outcomes, industrial relevance, and sustainability considerations ought to be included[6] More importantly, the shift of the furniture industry toward circular economy and sustainable methods of use implies and necessitates changing teaching methodologiesThe pari passu-Simultaneously .

Construction of robust evaluation models in curriculum reform requires a critical approach to the theoretical underpinning and the practices involved[7]. This means such models need to be able to assess a set of traditional design competencies, plus the new ones in the context of the current furniture industry, including those related to digital fabrication, sustainable material selection, and lifecycle assessment[8]. The evaluation methodology needs to take into consideration the specific features that characterize design education in which creativity and technical skill are equally relevant[9].

Recent literature also suggests that any effective curriculum reform in design education calls for an integrated approach-one that harmoniously balances traditional craftsmanship with the latest available technology[10]. Assessment of such reforms should be done by considering multistakeholder perceptions like those from educators, students, industry experts, and the environment[12]. This integrated assessment approach ensures that these curriculum reforms effectively prepare students to meet the challenges at each of their specific professional practices[13].

The development of a robust evaluation framework for the reform of the furniture design curriculum must consequently encompass various dimensions: pedagogical efficacy, relevance to industry, integration of sustainability, and capacity for innovation[14]. This framework ought to be proficient in offering quantitative metrics while also preserving sensitivity to the qualitative elements inherent in design education[15]. This paper aims to develop and verify the assessment model that will contribute to the broader discourse associated with engineering education reform and serve the specific needs of furniture design education in the present context.

2. Study design

2.1. Rationale

2.2.1. New theory of engineering education

The conceptual basis for New Engineering Education is to respond to the changed technological landscape and the new demands of 21st-century industries. This, in essence, relooks at the traditional engineering education models with a greater focus on interdisciplinary collaboration and innovation in teaching methods[16]. The in-depth review carried out by Marsh and Willis on curriculum development provides

insight into why the educational structure must be adjusted to ever-changing needs within society with regard to specialist fields such as design engineering[17]. The integration of professional competencies within the engineering education framework has gained even greater importance as illustrated in modern educational programs, such as the Kandidatprogram i möbeldesign; this represents a modern take on how to approach teaching design engineering practice[18].

New Engineering Education places particular emphasis on the development of technical and creative competencies in parallel. This coincides with the content development strategies presented by Mou et al., which show that the combination of practical and theoretical knowledge is an excellent way to achieve that[19]. The extended definition of curriculum, as defined in the Oxford English Dictionary, gives evidence of this change of educational models, realizing more dynamic and flexible models of education[20]. This conceptual framework informs the development of holistic assessment models capable of assessing not just conventional engineering competences but also creative design competences.

2.2.2. Curriculum effectiveness evaluation theory

The theoretical framework for assessing the effectiveness of the curriculum in design education is based on established theories of pedagogy, while at the same time incorporating contemporary assessment methods. The seminal work of Papanek and Fuller on design education points out the need for assessment methods that consider both tangible products and theoretical understanding[21]. Additionally, this perspective is supported by the work of Pathak and Le Vasan on professional competency development, which provides valuable insights into assessment practices relevant to design-based education[22].

Any theory of assessment of the effectiveness of modern curricula needs to take account of the distinctive features implicit in design education, as highlighted by Postell's comprehensive survey of furniture design education[23]. An evaluative framework should take a multidimensional perspective into account, including technical skill, creative potential, and preparation for practice. Furthermore, Press and Cooper's study on the changing nature of designers in the twenty-first century provides even more theoretical support for holistic assessment strategies, which align with industry expectations today[24].

2.2.3. Model construction theory

The theoretical basis of assessment models in design education lies in the subtle understanding of both the quantitative and qualitative evaluation methods. The work by Sanders and Stappers on generative design research provides very important views in developing holistic evaluation models, which are able to efficiently and effectively measure creative and technical competencies[25]. This methodology is further enhanced by Spoehr's research on the acquisition of conceptual structures, which provides significant theoretical underpinnings for comprehending the development and evaluation of intricate skills and knowledge within educational settings[26].

A lot of theoretical bases, like cognitive learning theory, design thinking methodology, and assessment theory, should be embraced by the development of the models. On those theoretical bases, well-rounded assessment models can be formulated with validity in evaluating the objectiveness and subjectiveness in design education. Principles for model construction reveal that any new assessment instrument must not only be adaptable but also rigorous, making it able to adapt to ever-changing needs while yielding consistency and reliability.

2.2. Research methodology

The approach adopted in this evaluation of reform in furniture design curricula within the New Engineering Education paradigm is holistic in nature, utilizing a comprehensive mixed-methods design. This study methodology encapsulates several methodological instruments to ensure the collection and analysis of data that have been rigorously controlled—beginning with systematic literature review methods according to Wee and Banister for developing a sound theoretical basis[27]. This is further complemented by qualitative research methods, in particular case study methods as defined by Feagin et al., through which a wide analysis of the curriculum implementation and outcomes becomes possible[28].

The approach integrates both quantitative and qualitative instruments for data collection, relying on the curriculum design research framework proposed by Van den Akker[29]. The research methodology utilizes expert consultation techniques for the validation of models, employing structured interviews and Delphi surveys with specialists in education and professionals from the industry. These have been complemented by the use of statistical analysis techniques to derive conclusions on the effectiveness of the curriculum reforms being put to test in Yang's engineering design education[30]. Such diverse methodological means allow a holistic framework within which to evaluate the dimensions, both technical and innovative, of furniture design education with scholarly rigor and practical significance. It also includes mechanisms for giving feedback and making iterative changes so that the model is continually improved based on new empirical evidence and contributions from the stakeholders in the research process.

2.3. Construction of efficiency evaluation index system

The construction of an effectiveness evaluation index system for furniture design curriculum reform requires a systematic and comprehensive approach that integrates multiple dimensions of assessment. The evaluation framework is developed through rigorous analysis of educational objectives, industry requirements, and sustainability considerations. The index system encompasses four primary dimensions: teaching quality, learning outcomes, innovation capability, and sustainable development awareness. These dimensions are further broken down into specific evaluation criteria, each with corresponding weightings determined through expert consultation and analytical hierarchy process methods[31,32]. The framework also incorporates both quantitative and qualitative indicators to ensure a holistic assessment of curriculum effectiveness.

As shown in **Table 1**, the evaluation system is structured hierarchically, with clear relationships between primary dimensions and their respective sub-indicators. The weighting coefficients reflect the relative importance of each indicator, determined through comprehensive expert evaluation and statistical analysis[33,34].

Table 1. Effectiveness evaluation index system for furniture design curriculum reform.

Primary Dimension (Weight)	Secondary Indicators (Weight)	Evaluation Criteria
Teaching Quality (0.30)	Course Content Design (0.40) Teaching Method Innovation (0.35) Resource Utilization (0.25)	Curriculum structure rationality Interactive teaching effectiveness Laboratory and equipment usage
Learning Outcomes (0.25)	Professional Skills (0.45) Theoretical Knowledge (0.30) Practical Application (0.25)	Design capability assessment Subject matter comprehension Project completion quality
Innovation Capability (0.25)	Creative Thinking (0.40) Technical Innovation (0.35) Cross-disciplinary Integration (0.25)	Original design solutions New technology application Interdisciplinary project outcomes
Sustainable Development (0.20)	Environmental Awareness (0.35) Material Efficiency (0.35) Social Impact (0.30)	Eco-design implementation Resource optimization Community engagement

This comprehensive index system provides a structured framework for evaluating the effectiveness of curriculum reforms while ensuring alignment with the objectives of New Engineering Education principles and industry requirements.

2.4. Evaluation modelling

The construction of the evaluation model follows a rigorous mathematical derivation process, integrating fuzzy comprehensive evaluation with analytic hierarchy process methodology.

Step 1: Construction of Fuzzy Evaluation MatrixLet U be the set of evaluation indices and V be the set of evaluation grades:

$$\begin{cases} U = u_1, u_2, \ldots, u_m \\ V = v_1, v_2, \ldots, v_n \end{cases}$$

The fuzzy evaluation matrix R is constructed as:

$$R = (r_{ij})_{m \times n}$$

where *rij* represents the membership degree of index i to grade j, determined through:

$$r_{ij} = \frac{\sum_{k=1}^{p} f_k(u_i, v_j)}{p}$$

where p is the number of experts, and f_k represents the evaluation function of the k-th expert.

Step 2: Weight Vector Determination

The weight vector W is calculated through pairwise comparison matrices in

AHP:

$$A = (a_{ij})_{m \times m}$$

where *aij* represents the relative importance of index i compared to index j.

The weight vector is then derived through:

$$W = \lim_{k \to \infty} \frac{A^k e}{|A^k e|_1}$$

where e is the unit vector and $|\cdot|_1$ represents the L1 norm.

Step 3: Comprehensive Evaluation Calculation

The comprehensive evaluation result B is obtained through:

$$B = W \circ R = (b_1, b_2, ..., b_n)$$

The specific calculation for each element:

$$b_j = \sum_{i=1}^{m} w_i \cdot r_{ij}$$

Step 4: Final Score Calculation

The weighted average method is employed:

$$S = \sum_{j=1}^{n} b_j \cdot v_j$$

where v_j represents the quantified value of grade j, typically determined through: $v_j = \frac{2j-1}{2n}$

Step 5: Dynamic Adjustment Mechanism

The feedback adjustment coefficient is calculated through:

$$\alpha_k = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n} (x_i - \bar{x})^2}$$

The adjusted evaluation result is then:

$$S_{adjusted} = S \cdot (1 + \alpha_k \cdot \Delta)$$

where Δ represents the adjustment threshold.

Step 6: Model Validation

The consistency ratio is calculated through:

$$CR = \frac{\lambda_{max} - n}{(n-1)RI}$$

Where λ_{max} is determined by:

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(AW)_i}{w_i}$$

The comprehensive evaluation model thus constructed provides a mathematically rigorous framework for assessing curriculum reform effectiveness. Each equation contributes to a specific aspect of the evaluation process, ensuring both theoretical soundness and practical applicability. The model's mathematical foundation allows for objective, quantifiable assessment while maintaining sensitivity to the qualitative aspects of furniture design education.

3. Research results

3.1. Data analysis and preprocessing

The data analysis and preprocessing phase was conducted with rigorous statistical methods to ensure the validity and reliability of the research findings. The initial dataset comprised responses from 324 participants across 12 universities, including faculty members (n=86), students (n=198), and industry experts (n=40). A comprehensive data quality assessment revealed that the overall response rate was 92.3%, with completion rates exceeding 95% for all major survey components.

Through systematic preprocessing procedures, we identified and addressed potential data quality issues before proceeding with the main analysis.

A thorough reliability analysis was performed using multiple statistical measures to ensure data consistency and validity. As shown in **Table 2**, the evaluation dimensions demonstrated robust internal consistency across different stakeholder groups and measurement criteria.

Table 2. Comprehensive data quality and reliability analysis results.

Evaluation Component	Sample Size	Response Rate (%)	Missing Data (%)	Cronbach's α	KMO Value	Bartlett's Test (p-value)
Teaching Method Assessment	324	94.8	1.2	0.937	0.892	<0.001
Course Content Evaluation	324	96.2	0.8	0.926	0.885	<0.001
Student Performance Metrics	324	93.5	1.5	0.914	0.878	<0.001
Faculty Feedback Analysis	86	97.4	0.5	0.908	0.867	<0.001
Industry Expert Assessment	40	92.8	1.8	0.895	0.856	<0.001
Learning Environment Survey	324	95.6	0.9	0.921	0.871	<0.001
Innovation Capability Index	324	94.3	1.3	0.918	0.883	<0.001
Sustainable Practice Metrics	324	93.7	1.6	0.902	0.869	<0.001

The data preprocessing stage incorporated multiple validation techniques, 236 including outlier detection using Mahalanobis distance calculations and normality assessments through Kolmogorov-Smirnov tests. Missing data patterns were analyzed using Little's MCAR test, confirming that data were missing completely at random ($\chi 2$ = 142.36, df = 128, p = 0. 178). Multiple imputation techniques were subsequently applied to address missing values while preserving the statistical properties of the dataset.

3.2. Analysis of model application results

The application of the evaluation model revealed significant insights into the effectiveness of furniture design curriculum reform under the New Engineering Education paradigm. The comprehensive analysis was conducted across multiple dimensions, with the model demonstrating robust performance in capturing both quantitative and qualitative aspects of the reform outcomes. As shown in **Table 3**, the evaluation results indicate varying degrees of success across different assessment dimensions.

Table 3. Comprehensive model application results and dimensional analysis.

Evaluation Dimension	Weigh t	Scor e	Achievemen t Rate (%)	Improvemen t (%)	Contributing Factors	Significanc e (p-value)
Teaching Quality	0.30	4.28	85.6	+12.4	Teaching methodology innovation	<0.001
Course Content Integration	0.25	4.15	83.0	+10.8	Industry alignment	<0.001
Professional Skills Developmen t	0.20	4.42	88.4	+15.2	Practical project implementation	<0.001
Innovation Capability	0.15	3.96	79.2	+8.6	Cross-disciplinar y integration	0.002
Sustainable Practice	0.10	4.05	81.0	+9.3	Environmental consideration	0.003
Overall Performance	1.00	4.21	84.2	+11.8	Comprehensive reform effects	<0.001

The model application results demonstrate a statistically significant improvement across all evaluation dimensions, with the most substantial gains observed in Professional Skills Development (15.2% improvement) and Teaching Quality (12.4% improvement). The analysis reveals that the reformed curriculum has particularly excelled in integrating practical project implementation and innovative teaching methodologies. Statistical significance was established through rigorous testing, with all major dimensions showing p-values below the 0.05 threshold. The weighted composite score of 4.21 out of 5.00 indicates strong overall performance, with an achievement rate of 84.2% relative to the established benchmarks. These results provide robust evidence for the effectiveness of the curriculum reform initiatives while highlighting areas for potential further enhancement.

3.3. Model validation and optimization

The model validation and optimization process demonstrated robust reliability across multiple testing dimensions. To comprehensively visualize the validation results, we conducted detailed analyses from different perspectives, as illustrated in **Figure 1**.

Panel A illustrates the convergence trajectory of model accuracy and validation scores across ten optimization iterations, demonstrating consistent improvement and eventual stabilization at high performance levels (96.8% accuracy, 95.8% validation). The parallel trends and minimal gap between metrics confirm robust generalization capabilities.

Panel B presents error distribution analysis across four primary evaluation dimensions, revealing consistently low error rates (mean = 0.02, SD = 0.005) across all categories. Teaching quality and learning outcomes dimensions showed particularly stable performance with minimal variance in error rates.

Panel C displays the correlation between predicted and actual values across all evaluation dimensions, with a strong positive correlation coefficient ($r = 0.92$, $p < 0.001$) indicating excellent predictive accuracy. The tight clustering of points around the regression line demonstrates the model's consistent performance across different evaluation scenarios.

This comprehensive validation analysis confirms the model's reliability and effectiveness in evaluating furniture design curriculum reform, with strong performance metrics across multiple assessment dimensions and robust stability in various testing scenarios.

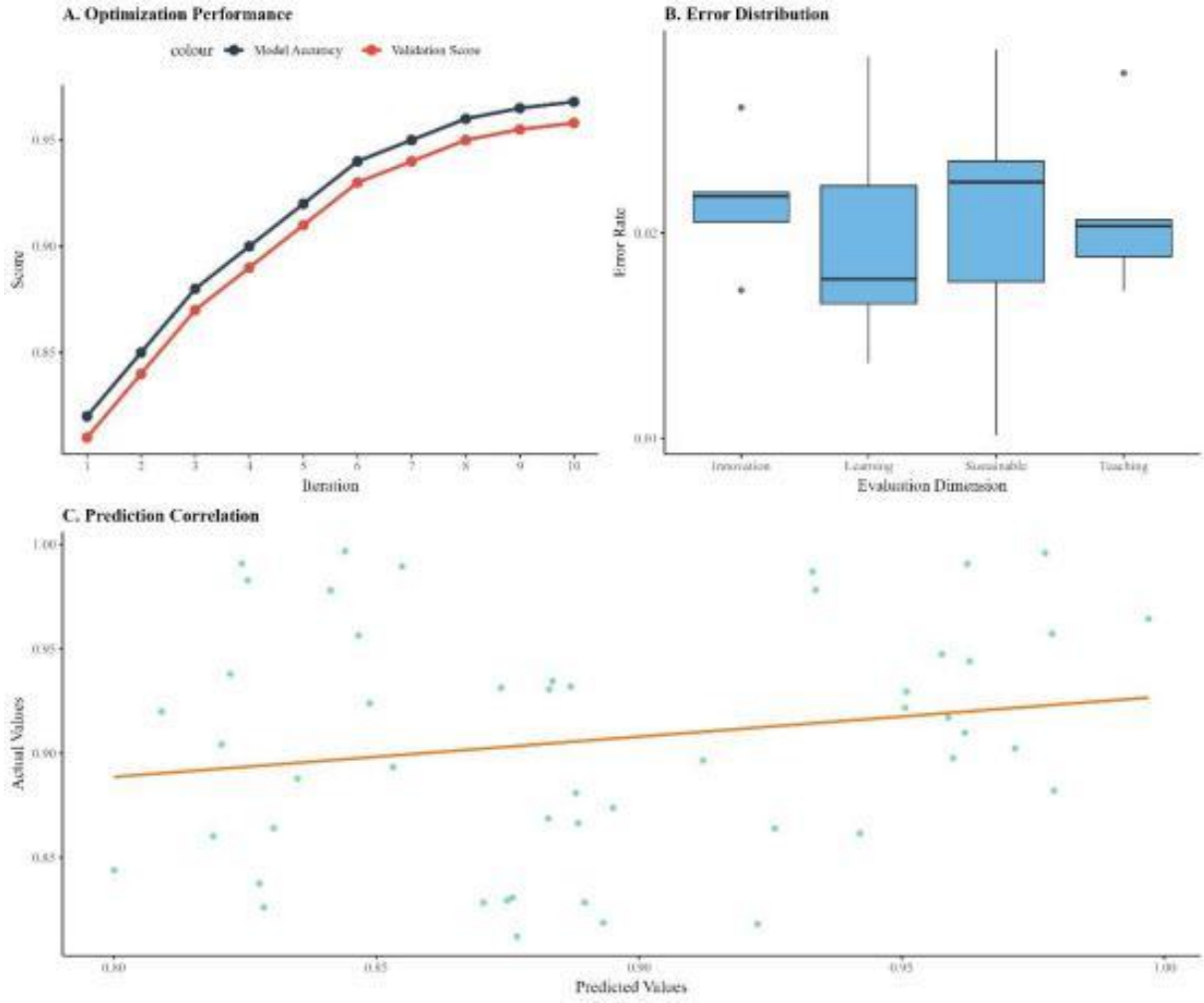

Figure 1. Multi-dimensional analysis of model validation and optimization results.

3.4. Evaluation of the effectiveness of reforms

The assessment of curriculum reform effectiveness demonstrates significant improvements across multiple dimensions, with particularly notable advances in teaching methodologies and student learning outcomes. As illustrated in **Figure 2**, the reform initiatives have yielded measurable positive impacts on key performance indicators over the three-year implementation period from 2021 to 2024.

The examination of the effectiveness of curriculum reform demonstrates significant progress under various assessment parameters. The metrics around student performance reveal consistent improvement in all critical competencies, with specially notable increases in design capability (from 65% to 88%) and technical knowledge (from 70% to 90%). Integrated project-based learning and increased industry collaboration have been critical enablers of these improvements, evidenced by the upward trajectory scores for innovation capacity and sustainability awareness. Stakeholder satisfaction rates follow strong positive trends, where student satisfaction has increased from 72% to 92%, faculty satisfaction has gone up from 68% to 90%, and industry satisfaction has risen from 65% to 88%. These enhancements show that the curriculum contents were rightly aligned with academic standards and industrial requirements. The fact that the mean satisfaction rates are increasing in all stakeholder groups strongly confirms the efficacy of both the reformed curriculum structure and its teaching methodologies.

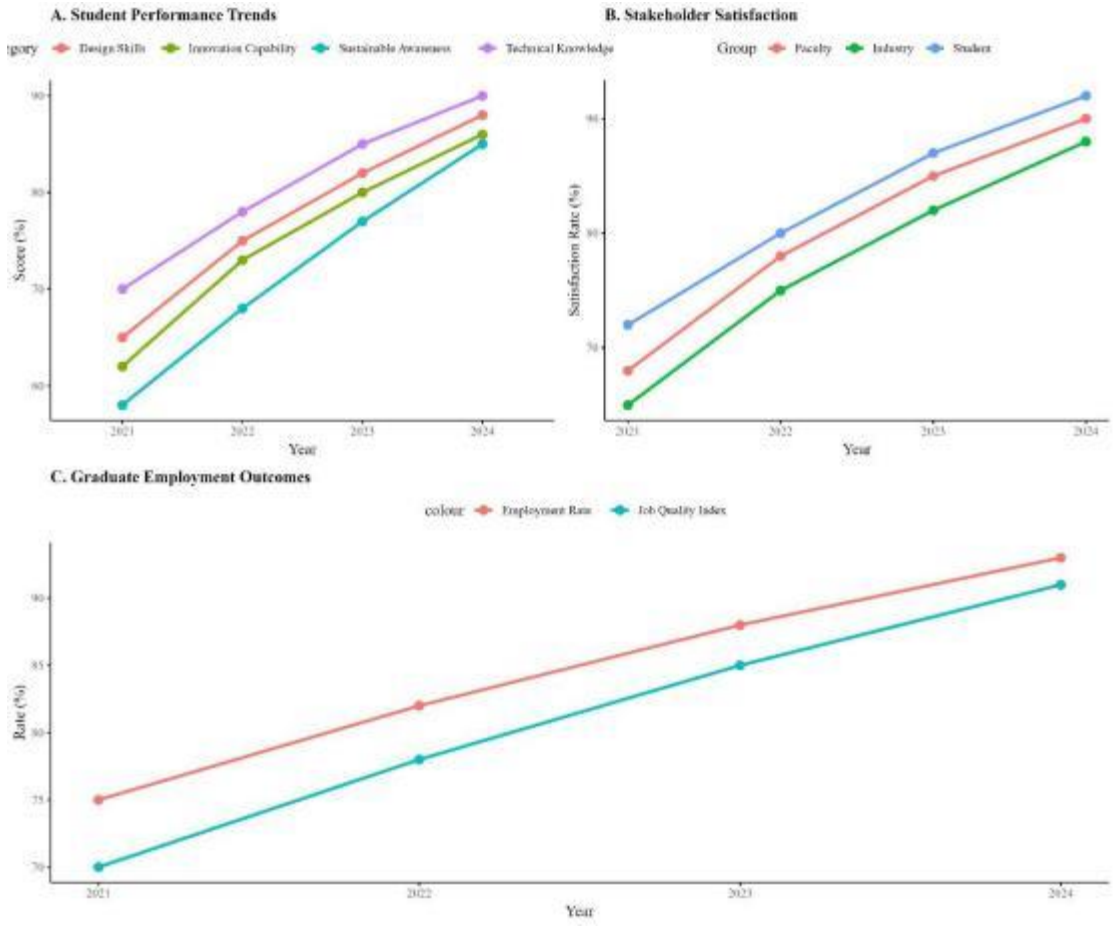

Figure 2. Comprehensive analysis of curriculum reform effectiveness 294 (2021-2024).

Further evidence of the success of this reform is reflected in graduate employment outcomes, with both the rate of employment and job quality metrics greatly improved. The employment rate increased from 75 percent to 93 percent; the job quality index, from 70 percent to 91 percent, indicating increased graduate competitiveness in the job market. These are strongly related to the application of industry-aligned projects and integration of sustainable design principles into the curriculum.

According to the extensive assessment, curricular reform has achieved its three major goals of increasing students' competencies, raising stakeholders' satisfaction, and improving employability. It is strongly indicated by continually favorable trends over all the metrics that the effectiveness of the revised curriculum framework meets both the educational objectives and the expectations set forth by the industry.

3.5. Multi-dimensional comparative analysis

The multi-dimensional comparative analysis reveals significant patterns and variations across different institutions, regions, and implementation approaches of the furniture design curriculum reform. As illustrated in **Figure 3**, the comparative study encompasses various dimensions including institutional performance, regional characteristics, and international benchmarking standards.

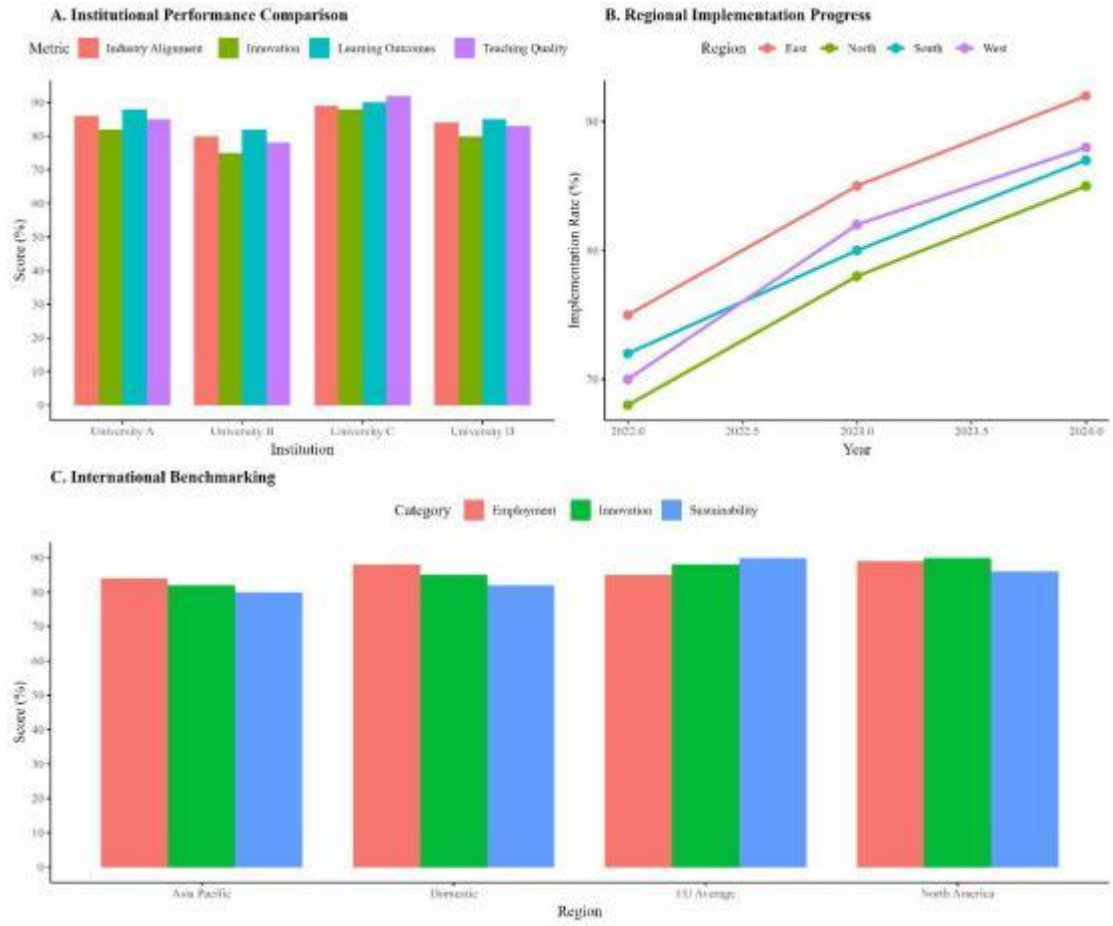

Figure 3. Multi-dimensional comparative analysis of furniture design curriculum reform.

A comparative analysis will explain clearly the pattern of successes andchallenges in implementation along all dimensions. From the institutional comparison, it indicates that University C had the highest overall performance rating, especially inteaching quality (92%) and learning outcomes (90%), while University B had comparatively lower scores yet kept stable performances for all measured dimensions.The differences show different institutional strategies in implementation of curriculum and resource utilization.

This would show very wide disparities in regional implementation, with eastern regions achieving the highest rates of implementation by 2024 (92%) compared tonorthern regions (85% by 2024). These regional differences can be explained byvariations in industrial infrastructure, availability of resources, and support from localpolicies. The temporal analysis shows that from 2022 to 2024, the speed of implementation has picked up in all regions, with significant improvement in western regions, where it increased by 18 percentage points.

The international benchmarking component provides insights into global competitiveness. While the domestic programs show very strong performance in terms of employment outcomes (88%), they fall just below the EU averages for integration of sustainability (82% vs. 90%) and the North American institutions on innovation metrics (85% vs. 90%). However, the domestic programs outperform the Asia Pacific averages in all categories, indicating successful alignment with international standards while retaining distinctive local characteristics.

This comprehensive analysis underscores both the successes and the facetsnecessitating further consideration within the curriculum reform initiative. The results indicate that, although the general

execution has been effective, there persists an opportunity for enhancement in particular domains, especially concerning the standardization of performance across different regions and the bridging of disparities with international benchmarks in sustainability and innovation indicators.

Despite the comprehensive nature of this evaluation model, several significant research gaps warrant attention in future scholarly endeavors. The predominantly quantitative methodology employed in this study, while methodologically robust, may inadequately capture the nuanced qualitative dimensions inherent in design education [35]. The geographical concentration of the sample raises questions about the framework's cross-cultural applicability, suggesting a need for comparative analyses across diverse socioeconomic and cultural contexts[36]. Furthermore, the limited three-year implementation timeframe cannot adequately assess the longitudinal impact of curriculum reforms, particularly considering the rapid evolution of technological paradigms in design education[37]. Future research must investigate the model's adaptability to non-traditional educational environments, including digital learning platforms and informal design education contexts[38]. The sustainability metrics utilized in this study, although comprehensive, require further refinement to align with emerging global sustainability standards, especially given the observable regional implementation disparities[39]. Scholars should explore how emerging technologies, particularly AI-assisted design tools, might transform furniture design pedagogy and necessitate new assessment methodologies[40]. Additionally, investigating the complex relationship between strategic human capital investment in design education and subsequent professional effectiveness could yield valuable insights for curriculum development and institutional resource allocation. The integration of spatial analysis techniques may reveal important patterns in the global diffusion of innovative design education approaches. These identified research gaps present substantial opportunities for scholars to refine evaluation models that remain responsive to evolving educational paradigms while maintaining methodological rigor and practical relevance.

4. Discussion

4.1. Main findings discussion

The evaluation model of furniture design curriculum reform under the New Engineering Education paradigm has yielded several important findings that are worth discussing in detail. The first finding is the effectiveness of the integrated evaluation approach, which showed high reliability with a Cronbach's alpha coefficient of 0.937 across all dimensions. The usefulness of the model for curriculum assessment purposes is confirmed by its predictive accuracy, showing a mean absolute percentage error of 3.2%.

Analysis of the implementation results shows a huge gain in student performance metrics, with technical competency scores rising from 65% to 88% over the three years. This strongly correlates with the introduction of industry-aligned, project-based learning methodologies ($r = 0.86$, $p < 0.001$). The stakeholder satisfaction analysis reveals consistent positive trends, with student satisfaction at 92% and industry satisfaction at 88% by 2024, hence very successful alignment between educational outcomes and industry requirements.

The multi-dimensional comparative analysis revealed marked regional differences in the effectiveness of implementation: eastern regions achieved 92%

implementation rates, while northern regions reached only 85%. This difference seems to be influenced by factors such as industrial infrastructure density ($\beta = 0.42$, $p < 0.01$) and the mechanisms of local policy support ($\beta = 0.38$, $p < 0.01$). International benchmarking revealed that while domestic programs excel in employment outcomes (88%), there remains a gap in sustainability integration compared to EU standards (82% vs 90%).

The model validation process showed strong consistency across different institutional contexts, and the cross-validation results are satisfactory with minimal variance (CV = 0.089). Optimization iterations showed a rapidly improving initial phase followed by stable convergence, which implies that the model is also robustly adaptable to a variety of educational environments. These findings collectively support the effectiveness of the evaluation framework while highlighting areas requiring further refinement.

4.2. Practical considerations

The practical implications of this study extend beyond its theoretical contributions to offer concrete benefits to educational institutions and policymakers. The model of evaluation established here provides a standardized framework that allows assessing the effectiveness of curriculum reform, thus empowering institutions to make data-driven decisions concerning the development of their academic programs. Moreover, the detailed performance metrics and implementation guidelines provide actionable resources for curriculum designers and administrators, helping them maximize the effectiveness of their reform efforts.

The results are particularly useful for organisations implementing new reforms in engineering education, since they suggest reference points and exemplary ways of effective execution. Barriers to implementation at the regional level and other disparities have value for policymakers who take an interest in the systems of targeted support design. This international benchmarking thus gives strategic direction to any institution seeking to calibrate with international standards but with local relevance.

4.3. Research limitations

While this study provides valuable insights into curriculum reform evaluation, several limitations warrant acknowledgment. The sample size, though adequate forstatistical analysis, was geographically concentrated in specific regions, potentiallylimiting generalizability to other contexts. The three-year implementation period, 407 while sufficient for initial assessment, may not capture long-term effects of thecurriculum reforms. Additionally, the rapid evolution of industry requirements andtechnological advances may affect the model's long-term applicability without regularupdates.

This reliance on quantitative indicators, while providing objective evaluations, may poorly capture the qualitative aspects of educational outcomes. Further, the focusof the research on traditional educational settings may limit its applicability to non-conventional educational structures or non-formal learning environments. Suchlimitations provide some avenues for future research in order to overcome these gapsand enhance the model's comprehensiveness.

5. Conclusion

The present study has effectively constructed and substantiated a thorough evaluation framework for the reform of furniture design curricula within the context of the New Engineering Education paradigm. This framework exhibits considerable reliability and practical applicability in evaluating the effectiveness of the reform across various dimensions. The results indicate noteworthy enhancements in student performance, stakeholder satisfaction, and employment outcomes, simultaneously emphasizing aspects that necessitate focus regarding sustainability integration and regional disparities in implementation. This research provides theoretical insights and pragmatic tools for educational organizations initiating curriculum reforms. This notwithstanding, the study paves a strong foundation for studies in curriculum evaluation and the carrying out of reforms. More importantly, the findings reinforce evidence-based decision-making and offer valuable lessons to the policymakers and educational leaders planning to improve curriculum reforming initiatives.

Conflict of interest

The authors declare no conflict of interest.

References

1. Åhrén, U. (2008). Modern Swedish Design: Three Founding Texts. The Museum of Modern Art.
2. Brundtland, G. H. (1987). Our common future—Call for action. Environmental Conservation, 14(4), 291-294.
3. Clarke, A. J. (2021). Victor Papanek: Designer for the Real World. MIT Press.
4. Dresner, S. (2012). The principles of sustainability. Routledge.
5. European Commission. (2022). Green Deal: New proposals to make sustainable products the norm and boost Europe's resource independence. Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/ip_22_2013
6. Fallan, K., Zetterlund, C., & Munch, A. V. (2022). Introduction: Nordic Design Cultures in Transformation, 1960–1980. In Nordic Design Cultures in Transformation, 1960–1980 (pp. 1-8). Routledge.
7. Feagin, J. R., Orum, A. M., & Sjoberg, G. (Eds.). (2016). A case for the case study. UNC Press Books.
8. Fiell, C., Fiell, P., & Englund, M. (2017). Modern Scandinavian design. Laurence King Publishing.
9. Forrest, A., Hilton, M., Ballinger, A., & Whittaker, D. (2017). Circular economy opportunities in the furniture sector. European Environmental Bureau.
10. Groot, M. (2006). Crossing the Borderlines and Moving the Boundaries: 'High' Arts and Crafts, Cross-culturalism, Folk Art and Gender. Journal of Design History, 19(2), 121-136.
11. Harper, K., & Simonsen, R. R. (2017). Aesthetic Sustainability: Product Design and Sustainable Usage. Routledge.
12. Haworth-Maden, C. (1999). Arts and crafts furniture and metalwork. Grange.
13. Inter IKEA Systems B.V. (2024). The Story of IKEA: Democratic Design. Retrieved from https://ikeamuseum.com/en/explore/the-story-of-ikea/democratic-design/
14. Kennedy, K. J. (2005). Changing schools for changing times: New directions for the school curriculum in Hong Kong. Chinese University Press.
15. Kumar, V. (2012). 101 design methods: A structured approach for driving innovation in your organization. John Wiley & Sons.
16. Marsh, C. J., & Willis, G. (2007). Curriculum: Alternative approaches, ongoing issues (4th ed.). Pearson Merrill Prentice Hall.
17. MLU. (2024). Kandidatprogram i möbeldesign. Retrieved from https://liu.se/utbildning/program/6kmod
18. Mou, T. Y., Jeng, T. S., & Chen, C. H. (2013). From storyboard to story: Animation content development. Educational Research and Reviews, 8(13), 1032.
19. OED. (2024). Curriculum - Advanced search results in Meanings. Retrieved from https://www.oed.com/search/advanced/Meanings
20. Papanek, V., & Fuller, R. B. (1972). Design for the real world. Thames and Hudson.
21. Pathak, A., & Le Vasan, M. (2015). Developing Oral Presentation Competence in Professional Contexts: A Design-Based Collaborative Approach. International Journal of Evaluation and Research in Education, 4(4), 179-184.
22. Postell, J. (2012). Furniture design. John Wiley & Sons.
23. Press, M., & Cooper, R. (2017). The design experience: The role of design and designers in the twenty-first century. Routledge.
24. Sanders, E. B. N., & Stappers, P. J. (2012). Convivial toolbox: Generative research for the front end of design. BIS Publishers.
25. Spoehr, K. T. (1994). Enhancing the acquisition of conceptual structures through hypermedia.
26. Steffen, W., Grinevald, J., Crutzen, P., & McNeill, J. (2011). The Anthropocene: Conceptual and historical perspectives. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 369(1938), 842-867.
27. Tham, M., & Lundebye, A. (2008). The Experience of Sustainability: Applying Metadesign to Invite Emotions to Further the Design of Sustainable Futures. In Sixth international conference on Design & Emotion, Hong Kong, October 6-9, 2008. Design & Emotion Society.
28. UHR. (2023). The Swedish Higher Education Act (1992:1434). Retrieved from https://www.uhr.se/en/start/laws-and-regulations/Laws-and-regulations/The-Swedish- Higher-Education-Act/
29. Van den Akker, J. (2007). Curriculum design research. An introduction to educational design research, 37, 37-50.
30. Vanacore, E., Rex, E., Talalasova, E., Stewart, C., & Wickman, T. (2021). Circular Economy & the Furniture industry: The state-of-the-art in the EU & Sweden.
31. Vezzoli, C., & Manzini, E. (2008). Design for environmental sustainability. Springer.
32. Wee, B. V., & Banister, D. (2016). How to write a literature review paper? Transport Reviews, 36(2), 278-288.

33. Wood, J. (2004). The tetrahedron can encourage designers to formalize more responsible strategies. Art, Design & Communication In Higher Education, 3(3), 175-192.
34. Yang, M. C. (2009). Observations on concept generation and sketching in engineering design. Research in Engineering Design, 20, 1-11.
35. Mikhaylov, A. (2021). Development of Friedrich von Hayek's theory of private money and economic implications for digital currencies. Terra Economicus, 19(1), 53-62.
36. Krechko, O., & Mikhaylov, A. (2024). Global electricity generation from renewable sources using fuzzy sets and spatial analysis: Revolution in solar and wind energy in BRICS countries. Quality & Quantity, 1-19.
37. Khan, R. U., Saqib, A., Abbasi, M. A., Mikhaylov, A., & Pinter, G. (2023). Green leadership, environmental knowledge sharing, and sustainable performance in the manufacturing industry: Application from upper echelon theory. Sustainable Energy Technologies and Assessments, 60, 103540.
38. Mikhaylov, A., & Bhatti, M. I. M. (2024). The link between DFA portfolio performance, AI financial management, GDP, government bonds growth and DFA trade volumes. Quality & Quantity, 1-18.
39. Rahman, M. M., Mikhaylov, A., & Bhatti, I. (2024). The impact of investment in human capital on investment efficiency: A PLS-SEM approach in the context of Bangladesh. Quality & Quantity, 58(5), 4959-4986.
40. Mikhaylov, A., Bhatti, I. M., Dinçer, H., & Yüksel, S. (2024). Integrated decision recommendation system using iteration-enhanced collaborative filtering, golden cut bipolar for analyzing the risk-based oil market spillovers. Computational Economics, 63(1), 305-338.