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INTEGRATION OF MULTIDISCIPLINARY KNOWLEDGE INTO INDUSTRIAL DESIGN CURRICULA

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Abstract. This article explores integrating multidisciplinary approaches into industrial design curricula, explicitly focusing on using biomimicry, cognitive science, and engineering disciplines. The aim of this study is to propose an educational model that incorporates these approaches to prepare students for solving complex design challenges in a rapidly evolving technological environment. The authors analyze the importance of creating an educational paradigm that fosters systems thinking, adaptability, and self-organization skills in students, which are crucial in rapid technological advancements. The research methodology includes a systematic analysis of curricula, a comparative analysis of teaching methods, and an evaluation of student projects. The results indicate that interdisciplinary learning can enhance student engagement and improve their preparedness for professional practice. Examples of biomimicry implementation illustrate how sustainable design can become the basis for creating environmentally responsible solutions. Cognitive approaches allow for the development of educational trajectories tailored to individual student characteristics. The authors conclude that implementing these approaches requires flexibility from educational institutions and further research to assess their long-term effectiveness more accurately.

Keywords: industrial design, multidisciplinary approaches, biomimicry, bionics, cognitive science, adaptive learning, sustainable design, systems thinking, engineering disciplines, educational paradigm, design innovation

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Introduction

Industrial design, a complex and multifaceted field, lies at the intersection of various theoretical and practical disciplines, such as the philosophy of perception, cognitive psychology, and ethnography. This diversity of approaches creates challenges in education, requiring a rethinking of how future designers are trained. Traditional educational programs, primarily focused on practical skills, can no longer fully prepare specialists to solve the complex problems they face in the modern world. The relevance of this research stems from the need to create educational models that broaden the focus beyond technical aspects and incorporate an understanding of the metaphysical interactions between humans and their environment.

Cultural archetypes, such as the Kazakh Shezhire (genealogy), play an important role in this context. They can be used as epistemological models to understand better the relationship between mental constructs and their material embodiment. This approach reveals the potential for integrating cultural values into the design process, making design not only a visualization tool but also a means of understanding and interpreting the world.

Industrial design education must consider global (macro) and local (micro) influences. Macro influences include global environmental and economic challenges that force a reconsideration of approaches to production and resource consumption. Local micro influences, such as cultural and territorial characteristics, shape unique user expectations. In this context, design becomes a powerful tool linking the phenomenology of space and time with cybernetics and systems thinking, requiring future designers to be able to adapt to constantly changing conditions.

Methods

A combination of methods was employed to ensure a comprehensive and systematic analysis of the educational programs to investigate the effectiveness of the multidisciplinary approach in industrial design education. These methods were selected to integrate various data sources, allowing for a deeper understanding of the impact of interdisciplinary learning on student preparation.

The first stage involved a systematic analysis of the curricula of key courses such as «Fundamentals of Industrial Design I» (OD 1303), «Elements and Processes of Industrial Design» (EPPD 2306), «Drawing and Model Making» (Ris 1210 and Mak 1223), and «Industrial Design Object Design» (POPD 4314). This method was chosen to identify how the allocation of teaching hours and the teaching methods used contribute to developing interdisciplinary thinking skills in students. Analyzing these courses allowed us to determine how successfully disciplines such as biomimicry, cognitive science, and engineering are integrated into the educational programs and identify any gaps in preparing students to solve complex problems.

The second stage of the research involved a comparative analysis of existing teaching methods. The comparison was based on a literature review of design educational strategies and instructor feedback. We compared traditional approaches focused on narrow specialization with multidisciplinary models to understand how integrating disciplines helps students develop complex thinking and adaptability. This method demonstrated how the multidisciplinary approach provides more effective learning and develops important skills. Data obtained from research papers (Brosens et al. 38) and the practical experience of educational institutions implementing similar models provided a reliable basis for comparative analysis.

The third stage involved evaluating student projects, analyzing the innovation, functionality, environmental friendliness, and social significance of the proposed solutions. Particular attention was paid to projects demonstrating the use of biomimicry and cognitive science principles. This stage was important for assessing the actual results of the educational process: how effectively students apply their acquired knowledge to develop sustainable and adaptive solutions. Evaluation criteria included the students' ability to use biological analogs for sustainable design and adapt to the requirements of real engineering problems. Data was collected through questionnaires and interviews with students and instructors to validate the findings. This provided qualitative feedback on the impact of the multidisciplinary approach on the learning process and allowed for adjustments to the curriculum based on the students' actual needs.

Thus, the chosen multi-level approach allowed for a comprehensive assessment of the influence of multidisciplinary methods on educational programs and confirmed the need for integrating knowledge from various fields to prepare future designers capable of effectively addressing contemporary complex challenges. The methodology was influenced by approaches emphasizing eco-friendly design and the dual "science-education-production" program as a foundation for industrial design education (Nurkusheva and Tolynbekova).

Discussion

The research (Brosens et al. 38) emphasizes the need to shift from traditional, localized approaches to curriculum reform towards more systemic methods based on design thinking principles (Figure 1). Prior studies have also explored the integration of eco-materials and sustainable practices in educational design, emphasizing the role of ecological awareness and interdisciplinary methods (Afonina et al.; Strizhak). The authors highlight the importance of applying design research methodologies, such as co-creation, where students, faculty, and industry representatives actively participate in curriculum development. A key aspect of this approach is the iterative development and prototyping process, which allows for adapting curricula based on regular feedback. This enables the creation of educational models that respond to the evolving needs of students. The role of biomimicry in education aligns with prior research that integrates natural systems and sustainable solutions into the design process (Zhdanov et al.; Uzakbayev and Nurkusheva).

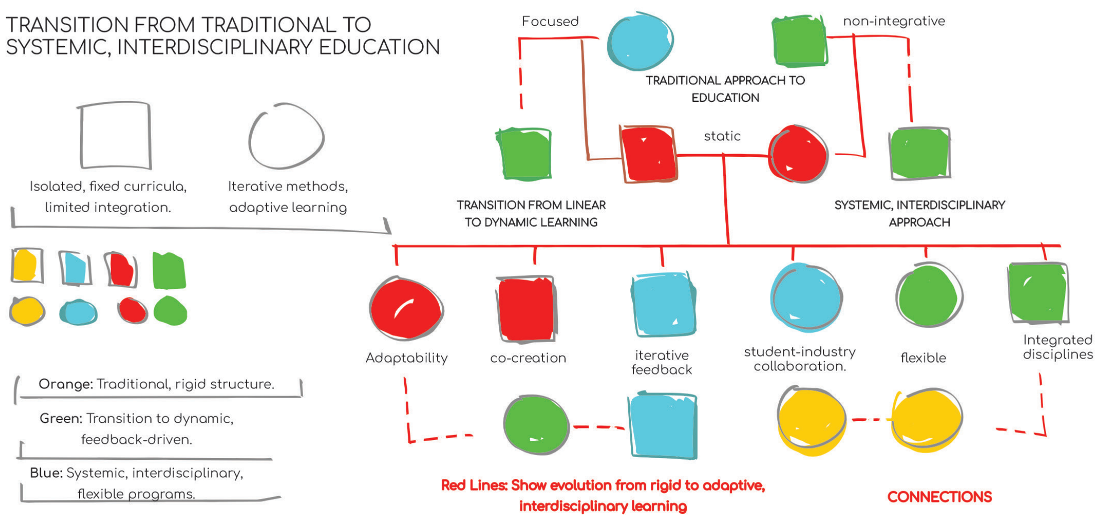

Figure 1 – Comparative framework of traditional and systemic approaches to education

Our approach is fully aligned with this methodology. In developing the «Fundamentals of Industrial Design I» (OD 1303) course, we employed the co-creation method, where students acted as co-authors of the educational process. This approach allowed us to consider their needs and preferences, ensuring greater program adaptability. The use of an iterative approach, where we regularly collected and analyzed feedback from students and faculty, enabled us to make timely improvements to the program. This confirms the relevance of our methodology and its ability to create a flexible educational ecosystem. Cultural aspects of design have also been explored, particularly in the context of national art and its futuristic potential in shaping modern environments (Imanbayeva and Nurkusheva).

Our approach to industrial design education draws upon philosophical, cognitive, and cultural concepts, deepening the exploration of mobile technology's impact on learning. For example, studies by Imanbayeva and Nurkusheva emphasize the integration of national art and futuristic ideas in shaping modern design, highlighting the importance of cultural specificity in education. For example, the philosophy of Martin Heidegger, who views technology as an extension of human essence, helps us understand mobile devices not merely as information transfer tools but as active mediators transforming the very nature of the educational process. Heidegger argues that technology expands the horizons of human activity, providing new possibilities for perceiving and interacting with the world. In the educational context, this means that mobile technologies become agents facilitating the creation of personalized learning experiences. Associative and figurative methods in scenography and film design highlight the importance of cognitive and emotional engagement in the learning process (Khalykov 2021).

Rather than viewing mobile devices as passive instruments, our approach sees them as active elements within the educational ecosystem, supporting student self-determination and self-organization. For instance, adaptive applications and digital platforms empower students to construct individual learning pathways, aligning perfectly with Heidegger's philosophical views on technology's role in human life.

Our educational approach is grounded in the principles of emergence, reflected in the concept of autopoiesis. We consider the educational process a dynamic system capable of self-development and transcendence without directive external control. This approach resonates with the decentralized nature of modern educational technologies, which facilitate the autopoiesis and adaptation of the learning process. Mobile technologies act as agents of transformation, responding to student intentionality and catalyzing the genesis of new educational paradigms (Figure 2).

For example, recursive adaptation algorithms allow for the dynamic modulation of course content to align with each student's epistemological profile and existential vectors. This embodies the principle of emergence: each student constructs their unique cognitive trajectory, which evolves in dialectical interaction with the changing environment. This approach empowers students to accumulate information and actualize their potential within the fluid reality of technological progress.

The crucial distinction between our approach and traditional models lies in synthesizing philosophical, cognitive, and cultural archetypes with mobile technologies. In dogmatic learning systems, mobile devices are primarily used for knowledge transmission. We, however, consider them an immanent component of the educational ecosystem, capable of influencing self-organization processes and generating new forms of interaction

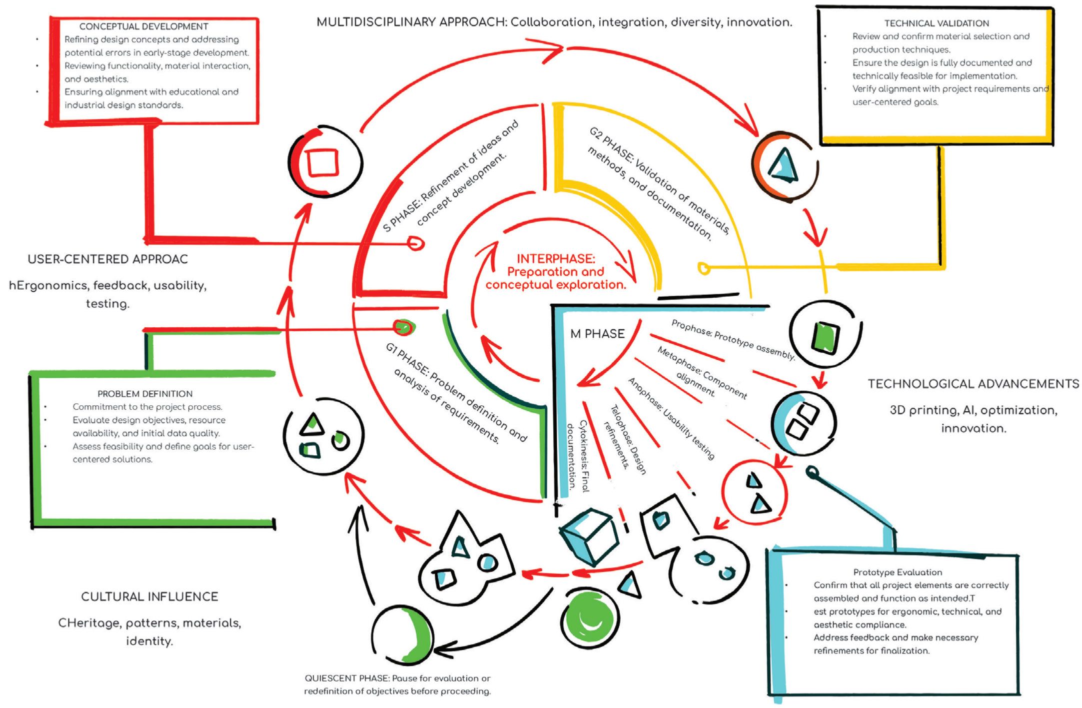

Figure 2 — Mobile complexes as agents of transformative learning in design education

between students and instructors. For instance, educational platforms developed within our model consider the individual phenomenology and cultural code of students. This optimizes the learning process and promotes personalization, which is critical in the context of globalization and the acceleration of technological change (Fleischmann 122).

Thus, mobile technologies become not just tools but catalysts for transformation, contributing to the formation of flexible and adaptive learning environments. Our approach helps construct educational ecosystems that respond to contemporary challenges and integrate cultural diversity, ensuring more profound and meaningful learning.

At the core of our educational model lies the principle of biomimicry, which studies the ontogenesis of natural systems to create resilient solutions in design and engineering. Similar ideas are supported by Musabayeva et al., who emphasize the importance of integrating sustainable materials into design education to minimize environmental impact. In the educational context, biomimicry allows us to design programs that, like living organisms, possess an inherent capacity for self-organization and adaptation. Applying biomimicry in educational processes catalyzes the genesis of dynamic educational tools that resonate with student needs and reflect the principles of evolutionary teleology and plasticity. For example, students extrapolate biological processes to develop sustainable materials and solutions, cultivating ecological awareness and responsible creation (Rzheutskaya and Kharina 25).

Also, in 1971, in the book «Design for the Real World,» Victor Papanek argued that design unrelated to the sociological and psychological aspects and ecology of the world around us is currently impossible and unacceptable. The artistic and technical design itself is currently impossible as a search for a functional and ergonomic form, divorced from solutions unrelated to sociological, psychological, aesthetic, ergonomic aspects, and environmental ecology. At the same time, Oskar Schlemmer's associative-figurative series was a key problem with the law of movement of the actor's body in space. Within the framework of the German Bauhaus school, Oskar Schlemmer's work contributed to the understanding of theatrical scenic events in the field of art in order to design space as an integral structure of harmony of a moving person in a system of functional movement in the life process and the environment in which a person lives, both in the past and the future, along with this, bionics and bionic research in industrial design. At this stage of the educational process, it is very important to provide students with an information base related not only to bionic information characteristics in design but also to modern specialists working in the field of real and design components of design should increasingly include environmentally sustainable materials in their developments, and at the stage of the basic educational process receive information about the latest technologies that provide environmental safety for humans and the environment (Papanek 45).

Cognitive epistemology also plays a fundamental role in transforming educational strategies. Studying the mechanisms of perception, information processing, and encoding allows for the development of approaches synchronized with student memory, attention, and learning characteristics. Research verifies that considering individual cognitive modalities optimizes the assimilation of educational material. This opens up prospects for creating personalized learning pathways that consider the epistemological potential of each student. For instance, synthesizing cognitive theories with technology facilitates the development of more effective teaching methods, enhancing the quality of the educational process (Table 1).

Integrating these approaches into educational models refines teaching practices and contributes to the formation of resilient educational ecosystems. These systems can dynamically adapt to fluctuations in the external environment, including technological and cultural transformations. The synthesis of biomimicry and cognitive science ensures a balance between theoretical knowledge and practical skills, creating conditions for developing specialists capable of solving multimodal problems. Such approaches allow for the construction of educational strategies adequate to the challenges of globalization and technological progress,

Table 1. Key concepts and impacts of transformative educational approaches

Concept	Description	Impact on Education
Mobile Technologies as Catalysts	Mobile technologies act as transformative agents, creating flexible and adaptive learning spaces.	Facilitates the development of educational ecosystems that respond to modern challenges and embrace cultural diversity.
Biomimicry in Education	Inspired by natural systems, biomimicry helps design programs that are self-organizing and adaptive.	Enables the creation of dynamic educational tools that resonate with students' needs and foster ecological awareness.
Cognitive Epistemology	Focuses on perception, processing, and encoding of information, aligned with students' cognitive traits	Promotes personalized learning paths, enhancing material assimilation and improving the quality of education
Integration of Approaches	Combining biomimicry and cognitive science ensures a balance of theory and practical skills.	Prepares adaptable professionals ready to solve complex, multidisciplinary challenges in a globalized world.

integrating students' cultural and social characteristics (Table 1).

In conclusion, using multidisciplinary paradigms based on biomimicry and cognitive science opens new horizons for creating innovative educational platforms. These adaptive and multimodal strategies provide culturally and individually oriented learning, preparing specialists to solve complex problems in the contemporary era. Thus, our proposed educational paradigm stimulates the development of creative and critical thinking, which is essential in the context of the permanent transformation of technologies and social structures (Cummings and Freeman 62).

Results

Our research findings suggest the potential effectiveness of a multidisciplinary paradigm that integrates biomimicry, cognitive epistemology, and engineering disciplines to optimize educational programs in industrial design. The synthesis of these methods can contribute to developing systemicthinking, adaptive potential, and self-organization skills among students—key competencies useful for addressing polymodal challenges in rapidly evolving technological environments.

Biomimicry, in particular, can enable future designers to generate environmentally sustainable solutions inspired by nature's principles. This approach allows students to not only design functional objects but also integrate resilience and efficient resource utilization principles. Cognitive science, in turn, can enhance perceptual and analytical abilities, fostering a deeper understanding of design tasks and the ability to adapt to new requirements. Engineering disciplines bridge theoretical concepts with practical applications, empowering students to develop innovative products that meet contemporary standards.

An analysis of successful educational programs, such as the courses «Fundamentals of Industrial Design» and «Project Graphics», illustrates how interdisciplinary learning can address not only technical but also philosophical and environmental challenges. Students build competencies to tackle existential issues and work effectively in project-based environments by integrating diverse disciplines. These courses promote a holistic design approach considering technical, cultural, and environmental aspects.

Our data analysis points to potential improvements in educational programs through the integration of multidisciplinary methods. These methods are anticipated to enhance students' cognitive engagement, adaptability, and self-organization capabilities. The predicted improvement in performance metrics, estimated at 15–30%, is a preliminary assessment that requires further empirical validation. Although this projection is based on the analysis of successful case studies and literature reviews, additional research, with specific examples and long-term observations, is needed for a more accurate assessment of effectiveness.

The incorporation of biomimicry into educational courses, such as "Elements and Processes of Industrial Design" (EPPD 2306), demonstrates how studying natural structures and processes can aid students in developing sustainable materials and design solutions. This could lead to reduced resource consumption and minimized environmental impact, crucial aspects of modern industrial design. Using biological analogs can help students understand how nature's principles can be adapted for sustainable design, fostering eco-oriented thinking and an innovative approach to solving engineering problems.

These interdisciplinary courses can also raise students' awareness of the environmental and social consequences of their design decisions. Students learn to apply cognitive strategies for deeper analysis of design requirements and adaptation to real-world engineering practice conditions. This underscores the importance of preparing specialists capable of responding effectively to contemporary challenges and creating meaningful, sustainable projects.

The application of philosophical and biological concepts in educational models can contribute to creating a more cohesive and sustainable learning ecosystem. For example, the concept of self-organization, derived from synergetics, can be observed in how student project teams learn to adapt to changing conditions and distribute roles during project work. Such practices can enhance collaborative skills, where students interact and adjust their actions based on external factors, potentially improving their ability to handle complex and unpredictable design situations.

The integration of philosophical approaches, such as the ideas of autopoiesis (the self-reproduction capability of systems), can enable students to reflect on their design processes in terms of self-organization and self-regulation. Such educational methods can foster systemic thinking—understanding and managing complex systems while responding to changes in real environments. This is particularly important in today's technological and social context, which demands flexibility and innovation from future specialists.

In conclusion, our research highlights the importance of considering both macro and micro processes within the educational environment. Global challenges, such as climate change and the need for sustainable development, call for solutions that harmonize with natural ecosystems. Simultaneously, educational programs must consider local features, including the cultural and social contexts of students. Our approach aims to achieve this balance, striving to create adaptive and dynamic educational systems that help students develop both technical and intellectual competencies.

Basic Provisions

This study examines integrating multidisciplinary knowledge into industrial design curricula, focusing on the intersection of biomimicry, cognitive science, and engineering disciplines. The evolution of industrial design education is marked by increasing demands for adaptability, systems thinking, and sustainability, all of which are addressed through the proposed educational paradigm. Traditional approaches to design education have often prioritized technical proficiency over holistic and adaptive methodologies, creating gaps in preparing designers for contemporary challenges.

This research proposes and evaluates a multidisciplinary educational model that fosters systemic and critical thinking, adaptability, and the ability to address complex design problems. It distinguishes itself from previous studies by emphasizing the synergy of natural principles, cognitive science, and technical application as the foundation for industrial design education.

Key issues identified include the need to integrate sustainable and adaptive design principles, the underrepresentation of cultural and cognitive approaches in current curricula, and the challenges of aligning educational programs with technological advancements. Unlike traditional methodologies, which often isolate disciplines, this study highlights the importance of interdisciplinary collaboration in fostering innovation and responsiveness in industrial design education.

The research demonstrates that adopting biomimicry and cognitive epistemology enhances students' ability to create environmentally responsible and user-centered solutions. The findings suggest that such an approach prepares students for professional practice and addresses global challenges by promoting sustainable and adaptable design strategies. This study contributes to the development of future educational frameworks, emphasizing the role of multidisciplinary learning in shaping resilient and innovative design professionals.

Conclusion

The research indicates the potential benefits of multidisciplinary approaches in industrial design educational programs, integrating biomimicry, cognitive science, and engineering disciplines. This combination of theoretical knowledge and practical skills may foster the development of systemic thinking and the ability to solve tasks in conditions close to professional practice. Applying these methods is likely associated with improvements in specific educational outcomes, such as increased student engagement and self-organization, which could better prepare them for the challenges of the modern world. However, more systematic and long-term studies are necessary for more substantiated conclusions.

Examples of using biomimicry in curricula, such as applying nature's principles to design environmentally sustainable solutions, illustrate how these approaches can lay the foundation for design innovation. Students studying biomimetic methods gain the ability to develop materials and structures with minimized environmental impact, which is becoming increasingly relevant in the context of growing ecological responsibility. The practical value of these methods lies in preparing specialists capable of creating sustainable and functional solutions that meet the demands of the contemporary market.

Furthermore, the research results highlight the importance of integrating cognitive and pedagogical methods to enhance students' adaptability and self-organization. For instance, courses with self-organization elements may enable students to allocate tasks and collaborate in team projects more effectively. This can have a positive impact not only on their academic performance but also on their readiness for real-world engineering practice. The long-term influence of these methods on student success requires further investigation, as many factors can affect project outcomes.

Based on the collected data, the following directions for developing educational programs can be suggested:
• Expanding the use of sustainable design principles and biomimicry to create environmentally and socially responsible projects. • More active use of cognitive strategies and pedagogical methods to foster adaptive thinking and develop self-organization skills. • Integrating modern technologies, such as BIM and 3D printing, to increase design accuracy and improve the visualization of engineering solutions.

In the future, multidisciplinary approaches are likely to play an increasingly important role in educational programs, contributing to the training of specialists who will be able to integrate knowledge from different fields and adapt to the changing demands of the industry. The implementation of these approaches will require educational institutions to be flexible and able to respond quickly to changes in the technological environment. It is important to note that, despite the encouraging preliminary results, long-term studies in various educational contexts are needed to assess their impact better. Thus, the development and production of life support products that allow, with minimal expenditure of resources and energy, indirectly support the development of the earth's civilization in a safe way, preserving its natural resources. The State policy of the Republic of Kazakhstan supports the development of industrial education and is interested in "educating a new generation of industrial engineers. Currently, the common cultural space of Kazakhstan is, in fact, a large field and platform for the disclosure and thorough immersion in the reinterpretation of heritage, which we need to study from a new modern perspective.

In the future, multidisciplinary approaches are likely to play an increasingly important role in educational programs, preparing specialists who can integrate knowledge from various fields and adapt to the changing demands of the industry. Implementing these approaches will require educational institutions to be flexible and able to quickly respond to changes in the technological environment. It is important to note that, despite the promising preliminary results, a more comprehensive assessment of their impact will require long-term studies across various educational contexts.

Multidisciplinary approaches have the potential to enhance the educational process in industrial design; however, their successful implementation will depend on further analysis and the adaptation of programs to new challenges and opportunities. These findings are consistent with earlier studies, which underline the importance of integrating cultural, ecological, and cognitive aspects into design education (Cummings and Freeman; Zhanguzhinova and Karzhaubaeva).

Authors contribution:
L. Nurkusheva – defining the research concept, identifying the scope of tasks and developing research methodology. Scientific editing of the main text, abstract text, consulting and scientific guidance.

A. Ashimova – formation of the theoretical part of the text, work with sources and interpretation of the data obtained. Analysis and systematization of the material, execution of the practical part of the study.

Вклад авторов:
Л.Т. Нуркушева – определение концепции исследования, выявление круга задач и разработка методологии исследования. Научное редактирование основного текста, текста аннотации, консультирование и научное руководство.

А.М. Ашимова – формирование теоретической части текста, работа с источниками и интерпретация полученных данных. Анализ и систематизация материала, исполнение практической части исследования.

Авторлардың үлесі:
Л.Т. Нуркушева – әдістемесін әзірлеу. Негізгі мәтінді, аңдатпа мәтінін ғылыми редакциялау, кеңес беру және ғылыми жетекшілік ету.

А.М. Ашимова – зерттеу тұжырымдамасын анықтау, міндеттер ауқымын анықтау және зерттеу мәтіннің теориялық бөлігін қалыптастыру, дереккөздермен жұмыс және алынған мәліметтерді интерпретациялау. Материалды талдау және жүйелеу, зерттеудің практикалық бөлігін орындау.

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ӨНЕРКӘСІПТІК ДИЗАЙН ОҚУ БАҒДАРЛАМАЛАРЫНА МУЛЬТИДИСЦИПЛИНАРЛЫҚ БІЛІМДІ ИНТЕГРАЦИЯЛАУ

Аннотация. Бұл мақалада өнеркәсіптік дизайн оқу бағдарламаларына мультидисциплинарлық тәсілдерді енгізу мәселелері қарастырылады, оның ішінде биомимикрия, когнитивті ғылым және инженерия пәндерінің қолданылуы ерекше назарда. Зерттеудің мақсаты – студенттерді қарқынды дамып келе жатқан технологиялық ортадағы күрделі дизайндық міндеттерді шешуге дайындайтын білім беру моделін ұсыну. Авторлар жүйелі ойлауды, бейімделу қабілетін және өзін-өзі ұйымдастыруды дамытуға ықпал ететін білім беру парадигмасын құрудың маңыздылығын талдайды. Зерттеу әдістемесі оқу жоспарларын жүйелі талдауды, оқыту әдістерін салыстырмалы талдауды және студенттердің жобаларын бағалауды қамтиды. Нәтижелер мультидисциплинарлық оқыту студенттердің қызығушылығын арттырып, кәсіби практикаға дайындықтарын жақсартатынын көрсетеді. Биомимикрияны қолдану мысалдары тұрақты дизайн экологиялық жауапты шешімдерді жасаудың негізі бола алатынын көрсетеді. Когнитивті тәсілдер студенттердің жеке ерекшеліктеріне бейімделген білім беру траекторияларын дамытуға мүмкіндік береді. Авторлардың тұжырымы бойынша, осы тәсілдерді жүзеге асыру үшін білім беру мекемелерінен икемділік талап етіледі, сондай-ақ, олардың ұзақ мерзімді тиімділігін дәл бағалау үшін қосымша зерттеулер қажет.

Түйін сөздер: өнеркәсіптік дизайн, мультидисциплинарлық тәсілдер, биомимикрия, бионика, когнитивті ғылым, бейімделген оқыту, тұрақты дизайн, жүйелі ойлау, инженерия пәндері, білім беру парадигмасы, дизайн инновациялары.

Дәйексөз үшін: Нуркушева, Ляззат, және Ашимова Айбота. «Өнеркәсіптік дизайн оқу бағдарламаларына мультидисциплинарлық білімді интеграциялау». *Central Asian Journal of Art Studies.* 9, № 4, 2024, 291–305 бб., DOI: 10.47940/cajas.v9i4.953

Алғыс: Авторлар «Central Asian Journal of Art Sdudies» журналының редакторларына мақаланы баспаға дайындауға көмектескені үшін және анонимді рецензенттерге зерттеуге назар аударып, қызығушылық танытқаны үшін алғысын білдіреді.

Авторлар қолжазбаның соңғы нұсқасын оқып, мақұлдады және мүдделер қайшылығы жоқ екендігін мәлімдейді.

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ИНТЕГРАЦИЯ МУЛЬТИДИСЦИПЛИНАРНЫХ ЗНАНИЙ В УЧЕБНЫЕ ПРОГРАММЫ ПО ПРОМЫШЛЕННОМУ ДИЗАЙНУ

Аннотация. В данной статье рассматривается интеграция мультидисциплинарных подходов в учебные программы по промышленному дизайну, с особым вниманием к использованию биомимикрии, когнитивных наук и инженерных дисциплин. Цель исследования – предложить образовательную модель, которая включает эти подходы и готовит студентов к решению сложных задач в условиях быстро развивающейся технологической среды. Авторы анализируют важность создания образовательной парадигмы, способствующей развитию системного мышления, адаптивности и навыков самоорганизации у студентов, что особенно важно в контексте стремительного технологического прогресса. Методология исследования включает систематический анализ учебных программ, сравнительный анализ методов преподавания и оценку студенческих проектов. Результаты показывают, что междисциплинарное обучение может повысить вовлеченность студентов и улучшить их подготовленность к профессиональной практике. Примеры использования биомимикрии демонстрируют, как устойчивый дизайн может стать основой для создания экологически ответственных решений. Когнитивные подходы позволяют разрабатывать образовательные траектории, адаптированные к индивидуальным особенностям студентов. Авторы приходят к выводу, что реализация этих подходов требует гибкости от образовательных учреждений, а также дальнейших исследований для более точной оценки их долгосрочной эффективности.

Ключевые слова: промышленный дизайн, мультидисциплинарные подходы, биомимикрия, бионика, когнитивные науки, адаптивное обучение, устойчивый дизайн, системное мышление, инженерные дисциплины, образовательная парадигма, инновации в дизайне.

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