FUTURE CITIES AND ENVIRONMENT

Defining Key Elements for Sustainable Interior Architectural Education via Systematic Literature Review

REVIEW

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ABSTRACT

Sustainable interior architectural education stands as a pivotal force in shaping the future of design, environmental responsibility, and societal well-being. This abstract encapsulates the essential elements that define the foundation of such education. The primary goal of this research is to delineate the ten fundamental elements that constitute the framework for sustainable interior architectural education. This investigation draws upon Scopus-indexed papers published within the timeframe spanning from 2010 to 2023. Through a comprehensive analysis of these scholarly sources which contributed from 38 referred journals, this study aims to distill and define the key components that underpin the pedagogical approach to sustainable interior architecture. Sustainable Design Principles form the cornerstone, instilling the integration of environmental, economic, and social dimensions into design. Environmental Awareness is paramount, fostering a deep understanding of design's ecological footprint. Sustainable Materials and Construction underscore responsible material choices and construction techniques. Integration of Renewable Energy and Life Cycle Assessment equips students to harness clean energy and assess long-term environmental impacts. Social and Cultural Considerations emphasize designing spaces that respect diverse communities. Indoor Environmental Quality prioritizes occupants' health and well-being. Research and Innovation drive progress, fostering a culture of continuous improvement. An Interdisciplinary Approach encourages collaboration across disciplines. Professional Ethics and Responsibility ground future interior architects in integrity and accountability. These elements, woven into sustainable interior architectural education, empower graduates to create spaces that harmonize with the environment, enrich lives, and shape a more sustainable future.

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INTRODUCTION

Sustainability transcends conventional boundaries, encompassing the economic, societal, and environmental realms in a concerted effort to advance the United Nations Sustainable Development Goals (SDGs) by 2030 (Shu Fen Chou et al., 2023). In the realm of interior design education, the traditional focus on design theories and aesthetics is evolving. Instructors now bear the responsibility of guiding students to augment their expertise with a profound understanding of creative sustainability (Shu Fen Chou et al., 2023). The escalating recognition of environmental sustainability within the academic sphere of interior design necessitates a recalibration of educational programs. These programs must be not only updated but also restructured to facilitate the seamless integration of environmentally conscious contextualization into the very essence of interior spaces (Shu Fen Chou et al., 2021).

Education for Sustainable Development (ESD) is gaining global recognition as an integral component of high-quality education that contributes to sustainable development. Within the realm of interior design, the discipline encompasses two interrelated phases: the design stage, which includes space planning, interior design, and integration, and the construction stage, involving the installation of ceilings, walls, floors, and technical systems like plumbing and electrical work. In essence, interior design operates on two complementary levels, intertwining aesthetics and practicality (Shu Fen Chou et al., 2023; Chou et al., 2021).

Building upon this foundation, the curriculum at the School of Interior Design (SID) prioritizes a comprehensive approach. It centers on ten key elements, including Environmental Awareness, Sustainable Design Principles, Life Cycle Assessment, Integration of Renewable Energy, Sustainable Materials and Construction, Indoor Environmental Quality, Social and Cultural Considerations, Interdisciplinary Collaboration, Research and Innovation, and Professional Ethics and Responsibility. These elements collectively form the bedrock of a well-rounded interior design education program aligned with the principles of sustainability (Shu Fen Chou et al., 2023; Ninunroihan Jehtae, Arita Hanim Awang, and Noraini Ahmad, 2020).

In the era of sustainability, sustainable interior architectural education has emerged as a vital component. As emphasized by Shu Fen Chou et al. (2023), design educators bear the crucial responsibility of laying the groundwork for sustainability. While students acquire theoretical knowledge, educators are equally tasked with guiding them towards practical, real-world sustainable project practices. Thus, this paper aims to delve deeper into the identification of essential elements integral to sustainable interior architectural education.

LITERATURE REVIEW

According to Groat, L., & Wang, D (2013), Kamal Eldin Mohamed (2022), Camille de Gaulmynn, Karine Dupre (2019), Salih Ceylan (2021), and Simay Özkan & Begum Gokdag-Ersozoglu (2022), the sustainable interior architectural education focuses on teaching sustainable design principles, such as energy efficiency, passive design strategies, use of renewable materials, waste reduction, and water conservation. These principles aim to minimize the environmental footprint of buildings.

The key elements for sustainable interior architectural education are tabulated and shown in Table 1. In this study, there are total of 38 scholars being referred. In general, the key elements for sustainable interior architectural education can be categorized into ten (10) groups after referring to the journals, including Environmental Awareness, Sustainable Design Principles, Life Cycle Assessment, Integration of Renewable Energy, Sustainable Materials and Construction, Indoor Environmental Quality, Social and Cultural Considerations, Interdisciplinary Approach, Research and Innovation, and Professional Ethics and Responsibility as shown in Table 1, by accumulating ticks via referring journals.

METHODOLOGY

In this study employ a rigorous systematic literature review process to comprehensively and objectively analyse the existing body of knowledge related to key elements for sustainable interior architectural education. By following a well-defined methodology, the aim to identify the key elements for sustainable interior architectural education by relevant studies from diverse sources. This systematic approach enables to minimize bias, ensure transparency, and establish a robust foundation for the research findings. Through the systematic review, it is intended to provide a comprehensive overview of the current state of research, identify gaps in knowledge, highlight trends, and draw meaningful insights that contribute to a deeper understanding of key elements for sustainable interior architectural education.

The research methodology adopted for the present of research work is presented in Figure 1. In the initial phase, an exhaustive literature review is carried out to extract the key elements for sustainable interior architectural education. Further with the systematic literature review process where there (3) filters have been set. There are:

a) Filter 1 – Database selection for collection the journal. Where in this research, the Scopus journal has been chosen.
b) Filter 2 – Selection of keyword. The keywords used are: 'key elements' and 'sustainable' and 'interior architectural education'

NO.	AUTHORS (YEAR)	KEY ELEMENTS									
		ENVIRON MENTAL AWARENESS	SUSTAINABLE DESIGN PRINCIPLES	LIFE CYCLE ASSESSMENT	INTEGRATION OF RENEWABLE ENERGY	SUSTAINABLE MATERIALS AND CONSTRUCTION	INDOOR ENVIRON MENTAL QUALITY	SOCIAL AND CULTURAL CONSI DERATIONS	INTER DISCIPLINARY APPROACH	RESEARCH AND INNOVATION	PROFESSIONAL ETHICS AND RESPONSI BILITY
1.	Ali Basim Alfuraty (2020)		*			*					
2.	Alina Drapella-Hermansdorfer (2018)	*						*			
3.	Buket Asilsoy (2017)	*									
4.	Camille de Gaulmynn, Karine Dupre (2019)	*	*								
5.	Dejan Mumovic & Mat Santamouris (2018)	*	*	*	*	*					
6.	Dusan Licina et al. (2021)	*	*		*						
7.	Edward A. Johnson & Michael J. Mappin (2009)	*									
8.	Fatma S. Hafez (2023)	*	*	*		*					
9.	Groat, L., & Wang, D (2013)		*								
10.	Ikbal Ece Postalcı and Güldehan Fatma Atay (2019)							*			
11.	(Ismail et al., 2017)	*	*		*	*					
12.	(Celadyn, 2018)	*	*		*	*	*				
13.	Jubril Olakitan Atanda & Ayşe Öztürk (2018)							*			
14.	Kamal Eldin Mohamed (2017)	*	*								
15.	(Dhaouadi et al., 2022)		*								
16.	L. Maslucha, Y. E. Putrie (2020)	*	*			*	*				

(Contd.)

NO.	AUTHORS (YEAR)	KEY ELEMENTS									
		ENVIRON MENTAL AWARENESS	SUSTAINABLE DESIGN PRINCIPLES	LIFE CYCLE ASSESSMENT	INTEGRATION OF RENEWABLE ENERGY	SUSTAINABLE MATERIALS AND CONSTRUCTION	INDOOR ENVIRON MENTAL QUALITY	SOCIAL AND CULTURAL CONSI DERATIONS	INTER DISCIPLINARY APPROACH	RESEARCH AND INNOVATION	PROFESSIONAL ETHICS AND RESPONSI BILITY
17.	Laura B. Cole (2019)							*			
18.	Magdalena Celadyn (2020)	*	*		*	*					
19.	Mohammad Taleghani, Philip John Jennings (2010)				*						
20.	N W Meidayanti Mustika et al. (2021)	*		*	*			*			
21.	Neda Mirzaei et al. (2020)						*				
22.	Ninunroihan Jehtae, Arita Hanim Awang, and Noraini Ahmad (2022)	*	*	*	*	*	*		*	*	*
23.	Ozge Erkan (2013)								*		
24.	Paola Boarin, Antonio Martinez-Molina (2022)										
25.	Paola Boarin, Antonio Martinez-Molina (2022)	*	*		*						
26.	Rahaf Aloudeh, Manar Elmardi, Wael Sheta (2023)		*	*		*					
27.	S. Kuppusamy and T. Mari (2017)	*									
28.	Salih Ceylan (2021)		*								
29.	Shanta Pragyan Dash & Deepika Shetty (2020)							*			
30.	Shu Fen Chou (2023)	*	*			*	*	*	*	*	*

(Contd.)

NO.	AUTHORS (YEAR)	KEY ELEMENTS									
		ENVIRON MENTAL AWARENESS	SUSTAINABLE DESIGN PRINCIPLES	LIFE CYCLE ASSESSMENT	INTEGRATION OF RENEWABLE ENERGY	SUSTAINABLE MATERIALS AND CONSTRUCTION	INDOOR ENVIRON MENTAL QUALITY	SOCIAL AND CULTURAL CONSI DERATIONS	INTER DISCIPLINARY APPROACH	RESEARCH AND INNOVATION	PROFESSIONAL ETHICS AND RESPONSI BILITY
31.	Shu Fen Chou1 et al. (2021)					*	*				
32.	Simay Özkan & Begum Gokdag-Ersozoglu (2022)	*	*								
33.	Simay Özkan & Begum Gokdag-Ersozoglu (2022)	*	*							*	
34.	Talissa Bedran Linhares & Andrea Andrea Franco (2017)	*	*	*		*					
35.	Vanessa Gomes Silva (2022)	*	*	*		*					
36.	Veronika Kotradyová (2022)		*			*		*		*	
37.	Wael Rashan, Ayman Fathy Ashour (2017)		*	*		*	*				
38.	Yeliz Tülübaş Gökuç (2021)	*	*			*					
Total times referred		**22**	**24**	**8**	**9**	**16**	**7**	**8**	**3**	**4**	**2**

Table 1 Key elements for sustainable interior architectural education.

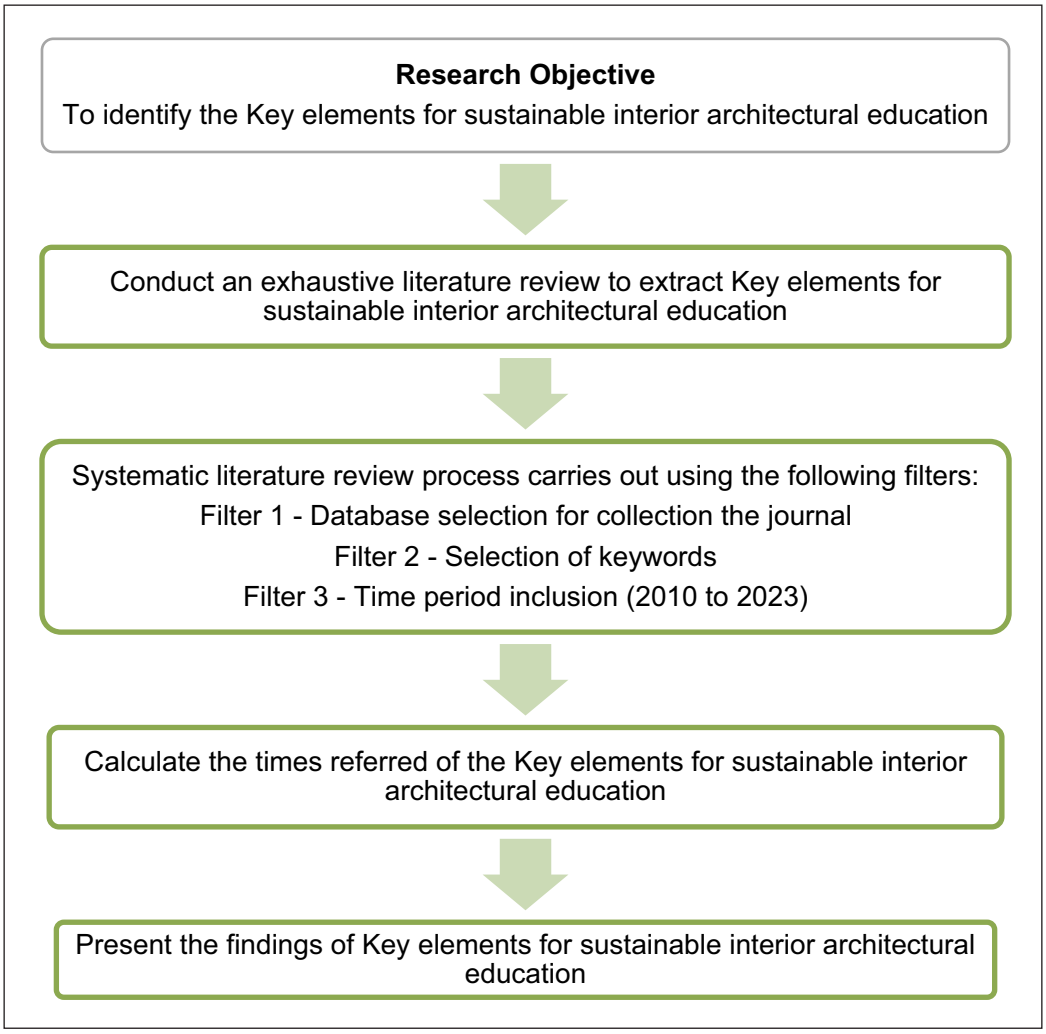

Figure 1 Research methodology.

c) Filter 3 – Time period inclusion between year 2010 to 2023.

A systematic review was conducted using a combination of the keyword highlighted above. The key elements for sustainable interior architectural education have been tabulated according to scholars and number of times referred to the attributes has been tabulated accordingly. Last stage, presenting the findings key elements for sustainable interior architectural education in the form of infographic presentation- sunburst. By referring to Figure 2., shown the numbers of journal has been used for this research. There are 38 journals in totals used for this research studies. The highest number of journals comes from year 2022 (7 journals) and follow by 2020 (6 journals).

RESULTS AND DISCUSSION

RESULTS

Based on Table 1, the ranking on times referred for key elements for sustainable interior architectural education rank based on the Table 2 below and further reflected on Figure 3 Spider-web tabulation numbers of times referred key elements for sustainable interior architectural education.

The ranking on ten (10) key elements for sustainable interior architectural education has been rank based on numbers of times referred and highlighted by the thirty-eight (38) scholars. The first rank is Sustainable Design Principles and follow by Environmental Awareness, Sustainable Materials and Construction, Integration of Renewable Energy, Life Cycle Assessment, Social and Cultural Considerations, Indoor Environmental Quality, Research and Innovation, Interdisciplinary Approach, and Professional Ethics and Responsibility.

DISCUSSION

Environmental Awareness

In an era defined by the urgency of environmental challenges, the imperative for designers and architects to embrace sustainability principles has never been more pronounced. This transformative journey commences with a fundamental understanding of environmental issues, an acknowledgment of their gravity, and an

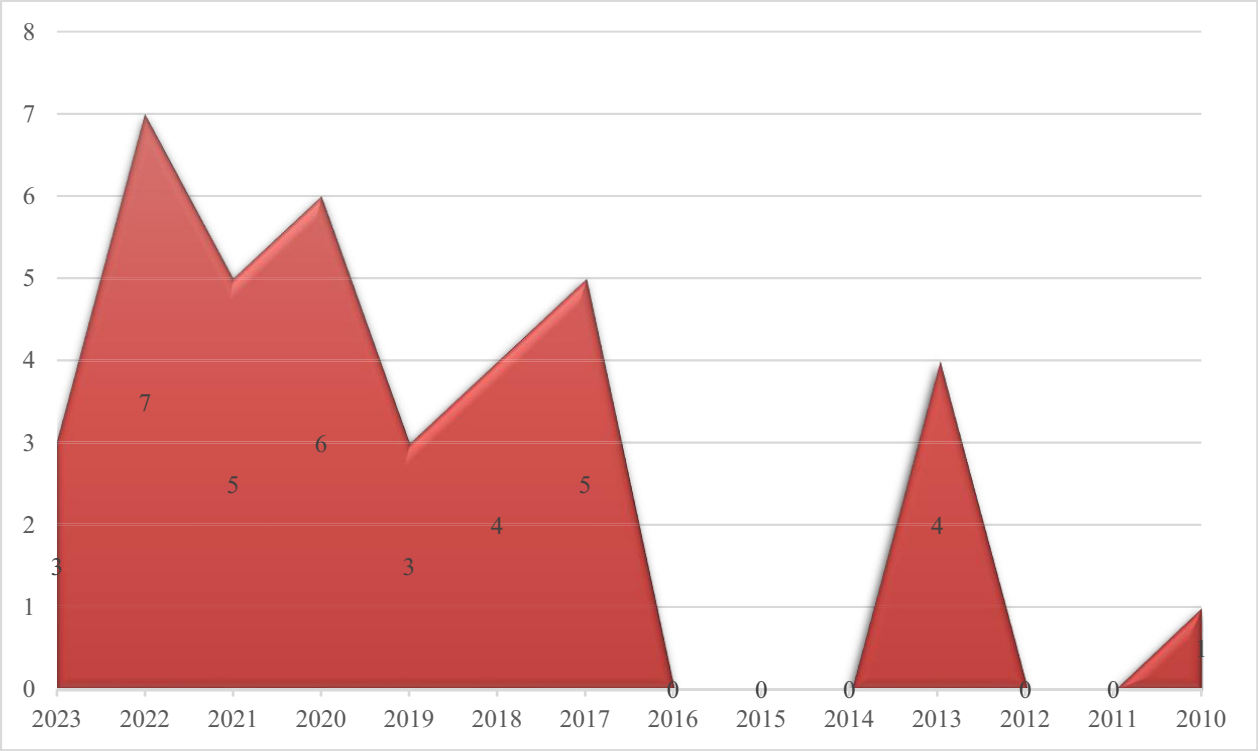

Figure 2 Number of journals referred according to year.

NO.	KEY ELEMENTS FOR SUSTAINABLE INTERIOR ARCHITECTURAL EDUCATION	TOTAL TIMES REFERRED	RANKING
1.	Environmental Awareness	22	2
2.	Sustainable Design Principles	24	1
3.	Life Cycle Assessment	8	5
4.	Integration of Renewable Energy	9	4
5.	Sustainable Materials and Construction	16	3
6.	Indoor Environmental Quality	7	7
7.	Social and Cultural Considerations	8	6
8.	Interdisciplinary Approach	3	9
9.	Research and Innovation	4	8
10.	Professional Ethics and Responsibility	2	10

Table 2 The ranking based on total times referred for key elements for sustainable interior architectural education.

appreciation of the intricate interplay of challenges that our planet confronts. As asserted by Alina Drapella-Hermansdorfer (2018) and Ali Basim Alfuraty (2020), this comprehension of environmental issues is akin to the compass guiding us towards a sustainable future. This understanding encompasses a broad spectrum of concerns, from the pervasive threat of climate change to the relentless depletion of finite resources, from the pervasive shroud of pollution to the disheartening loss of biodiversity. It is a recognition that our actions, both small and large, reverberate across the intricate tapestry of our planetary home. Venturing further, we confront the profound "Environmental Impact of the Built Environment." Here, the constructed world assumes a central role in the nexus of environmental challenges. The construction and operation of buildings significantly amplify resource consumption, contribute substantially to waste generation, and cast a considerable shadow in the form of greenhouse gas emissions. In alignment with insights from scholars such as Buket Asilsoy (2017) and Camille de Gaulmynn (2019), this phase of acknowledgment becomes the first stride towards responsible architectural practices. Armed with this environmental consciousness, designers can delve into the "Principles of Ecological Design." These principles forge the bedrock for conceiving spaces and structures that exist in symbiotic harmony with the natural world. It is a realization that design should not merely coexist with the environment but should actively strive to enhance it. Insights from scholars like Dejan Mumovic (2018) and Dusan Licina et al. (2021) shed light on the significance of these foundational principles. Following this foundation, we transition into "Sustainable Design Strategies." Herein lies the toolkit for designers to craft environmentally responsible solutions. These strategies encompass a wide spectrum of practices, from the judicious use of recycled materials to the meticulous optimization of

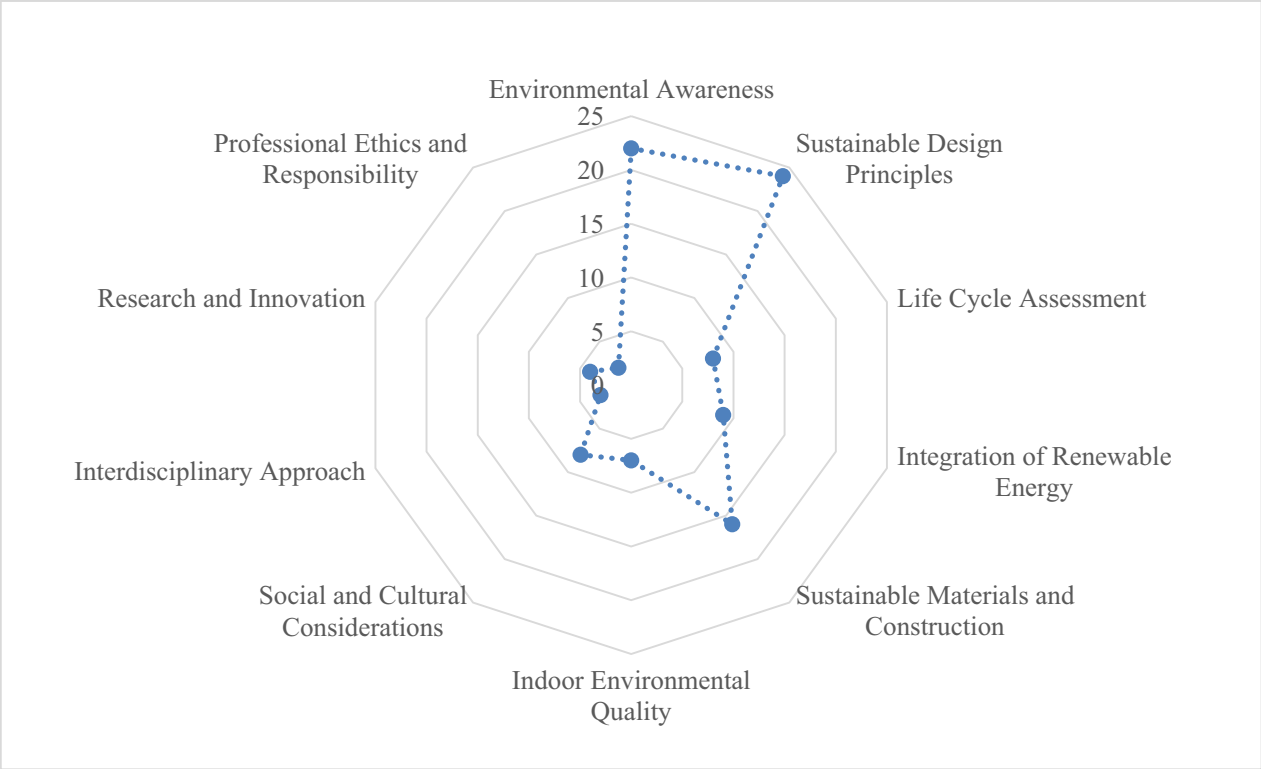

Figure 3 Spider-web tabulation numbers of times referred key elements for sustainable interior architectural education.

energy efficiency. It is the pragmatic bridge that connects theory to the practical realm. Contributions from scholars such as Edward A. Johnson (2009) and Michael J. Mappin, as well as insights from Fatma S. Hafez (2023), elucidate the multifaceted nature of sustainable design strategies. One of the pivotal facets of sustainability is "Climate-responsive Design." This entails tailoring architectural structures to effectively address climate challenges. It involves harnessing the natural elements for heating and cooling, thus diminishing energy demands. It's about aligning architecture with the dynamic landscape of a changing climate, as underscored by research from Alina Drapella-Hermansdorfer (2018) and Ali Basim Alfuraty (2020). Finally, the zenith of sustainability with "Circular Economy and Cradle-to-Cradle Design." This paradigm envisions a world where waste is minimized, and products are ingeniously designed to find rebirth as new materials, abolishing the concept of trash as we know it. Insights from scholars like Buket Asilsoy (2017) and Camille de Gaulmynn (2019) provide illuminating perspectives on this transformative approach.

Sustainable Design Principles

Sustainable design principles serve as the cornerstone of environmentally conscious architectural education, shaping the ethos of architects and designers as stewards of the planet. These principles constitute a comprehensive framework of ideas and practices dedicated to advancing not only the efficiency and aesthetics of spaces but also their harmonious coexistence with the natural world. Scholars like Dejan Mumovic and Mat Santamouris (2018) and Dusan Licina et al. (2021) underscore the paramount importance of these principles. At its core, sustainable design hinges on energy efficiency. This principle revolves around the strategic optimization of energy consumption within buildings, striving to curtail energy waste and mitigate greenhouse gas emissions. Strategies encompass advanced insulation, efficient heating and cooling systems, and intelligent lighting solutions, as elucidated by the research of Khansa Dhaouadi and Pierre Leclercq (2022). Passive design strategies exemplify sustainability's elegance. These techniques harness the inherent qualities of the natural environment to maintain ideal indoor conditions, sparing reliance on active systems. Sunlight becomes a natural heating source, cross-ventilation cools interiors, and precise building orientation minimizes energy demand. This approach, championed by scholars like Dejan Mumovic and Mat Santamouris (2018), embodies an environmentally attuned design philosophy. Embracing renewable energy sources, such as solar panels and wind turbines, epitomizes sustainable design. These technologies offer a dual benefit, providing clean, renewable energy while reducing dependence on fossil fuels. It's a cornerstone of sustainability, as echoed by the insights of Dusan Licina et al. (2021) and Khansa Dhaouadi and Pierre Leclercq (2022). Sustainable design extends its purview to water conservation, another critical facet of responsible architecture. This involves a spectrum of strategies, including low-flow fixtures, rainwater harvesting, and the creation of water-efficient landscapes. The aim is

to minimize water wastage, as highlighted by research from Laura B. Cole (2019) and Magdalena Celadyn (2020). The choice of building materials assumes a pivotal role in sustainable design. Selecting materials with minimal environmental impact involves a holistic assessment of their sourcing, recyclability, and durability. Laura B. Cole (2019) and Magdalena Celadyn (2020) emphasize the significance of these considerations. Sustainable design is intrinsically linked with waste reduction and recycling. It advocates for responsible construction practices that minimize waste generation and repurpose materials. This ethos aligns with the research of Laura B. Cole (2019) and Magdalena Celadyn (2020), who underscore the importance of mindful waste management. Lastly, biophilic design breathes life into spaces by integrating nature seamlessly into the built environment. Indoor plants, natural lighting, and views of green spaces nurture a profound connection between occupants and the natural world. Khansa Dhaouadi and Pierre Leclercq (2022) endorse this approach, highlighting its potential to enhance well-being.

Life Cycle Assessment

Life Cycle Assessment serves as a cornerstone in the curriculum of sustainable architectural education. This vital concept urges students to adopt a comprehensive perspective, one that transcends the immediacy of construction. It encourages them to contemplate the entire lifespan of a building, from its inception and construction to its continuous operation and eventual decommissioning. As elucidated by Dejan Mumovic and Mat Santamouris (2018), LCA equips students not only with an understanding of this holistic viewpoint but also with strategies for enhancing a building's environmental performance across its entire life cycle. This entails identifying avenues to curtail resource consumption, optimize energy efficiency, and minimize waste generation, as underscored by the research of Talissa Bedran Linhares and Andrea Andrea Franco (2017) and Vanessa Gomes Silva (2022). Central to LCA is the pivotal step of inventory analysis. This involves meticulously cataloging every material and resource that contributes to a building's construction and ongoing operation. This exhaustive inventory provides students with a quantifiable representation of the environmental inputs tied to a structure, as expounded by Vanessa Gomes Silva (2022) and Veronika Kotradyová (2019). Subsequently, impact assessment emerges as a critical phase. Here, students critically evaluate the environmental repercussions stemming from their architectural decisions. They scrutinize factors such as energy consumption, greenhouse gas emissions, and waste generation to gauge the cumulative impact of a building on its surrounding environment. This evaluative process, as elucidated by Talissa Bedran Linhares and Andrea Andrea Franco (2017), enables students to gauge the true sustainability of their designs. In essence, LCA empowers students with knowledge and tools that extend far beyond the drafting table. It equips them to make judicious and informed choices that prioritize sustainability throughout the entire lifespan of a building, from its initial conception to its eventual retirement, ensuring that every architectural endeavor contributes positively to both human habitation and the global environment.

Integration of Renewable Energy

Sustainable architectural education places a significant emphasis on seamlessly incorporating renewable energy systems, including technologies like solar panels, wind turbines, and geothermal systems, into the very fabric of building design. In this immersive educational journey, students not only gain a profound understanding of the advantages and complexities of these sustainable energy solutions but also learn how to masterfully weave them into architectural projects. The educational voyage commences with a robust foundation in comprehending the diverse spectrum of renewable energy sources. Students acquire a comprehensive understanding of clean energy forms, including solar, wind, and geothermal power, as elucidated by the research of Mohammad Taleghani and Philip John Jennings (2010) and N W Meidayanti Mustika et al. (2021). Sustainable architectural education delves deep into the realm of innovative strategies for seamlessly amalgamating renewable energy systems with building designs. Students embark on a creative exploration, devising solutions that not only harmonize these technologies with structures but also preserve aesthetics and functionality, a point emphasized by Ninunroihan Jehtae, Arita Hanim Awang, and Noraini Ahmad (2022). A pivotal facet of renewable energy integration is the mastery of energy storage and management techniques. Here, students delve into the intricacies of capturing and efficiently storing excess energy generated by renewables. This knowledge ensures a reliable and consistent power supply, as outlined by Dusan Licina et al. (2021). The educational odyssey culminates with students immersing themselves in energy modeling and analysis. They gain proficiency in the utilization of advanced tools and methodologies to rigorously assess the efficiency and performance of integrated renewable energy systems. This analytical prowess empowers informed decision-making throughout the architectural design process, aligning with the insights of Neda Mirzaei et al. (2020). Sustainable architectural education is an empowering voyage that equips students not only to comprehend the immense potential of renewable energy but also to translate this knowledge into tangible, practical design solutions. Through a holistic journey encompassing understanding, integration, storage, and analysis, students emerge as adept architects capable

of crafting buildings that not only harness the power of sustainability but also fulfill the needs of occupants while harmonizing with the environment.

Sustainable Materials and Construction

In sustainable architecture education, a pivotal focus lies on equipping students with the knowledge and skills to make conscientious choices in material selection and construction techniques (Ismail et al., 2017). This entails a deep understanding of environmentally friendly and non-toxic materials and the adoption of sustainable construction practices to minimize the ecological impact of building projects (Jan Matejko, 2018; Talissa Bedran Linhares & Andrea Andrea Franco, 2017). Sustainable architecture education places a significant emphasis on teaching students how to choose materials that are not only durable and functional but also environmentally responsible. This involves a comprehensive evaluation of materials, considering factors like their ecological footprint, recyclability, and health impacts (Vanessa Gomes Silva, 2022; Veronika Kotradyová, 2022). A critical aspect of sustainable material selection is conducting a life cycle assessment (LCA). Students learn to assess materials through their entire lifespan, from production and use to disposal. This helps in quantifying the environmental impacts of materials and guides decision-making toward the most sustainable options (Wael Rashan, Ayman Fathy Ashour, 2017). Students are introduced to materials that contribute to energy efficiency within buildings. This includes materials with superior insulation properties, daylighting characteristics, and thermal performance. The goal is to design structures that minimize energy consumption and reduce the need for heating, cooling, and lighting (Vanessa Gomes Silva, 2022). According to Wael Rashan, Ayman Fathy Ashour (2017) and further highlighted by Yeliz Tülübaş Gökuç (2021), Sustainable architecture education underscores the importance of materials with a low carbon footprint. These materials are typically sourced and manufactured with minimal greenhouse gas emissions. Students learn how to identify and incorporate such materials into their designs, reducing the overall carbon impact of a project. Beyond materials, students delve into sustainable construction practices. This encompasses a wide range of techniques, including efficient waste management, responsible water usage, and environmentally sound construction methods. Students are encouraged to adopt construction approaches that minimize resource consumption and environmental disruption (Jan Matejko, 2018). Sustainable architecture education often introduces students to green building certifications like LEED (Leadership in Energy and Environmental Design) or BREEAM (Building Research Establishment Environmental Assessment Method). These certifications set standards for sustainable building practices and provide a framework for students to understand and implement sustainable design and construction principles (Yeliz Tülübaş Gökuç, 2021). In essence, sustainable materials and construction education instills in students a holistic approach to building projects. They learn not only to select materials that are environmentally responsible but also to integrate these materials into construction processes that minimize ecological impact. This knowledge empowers future architects to design and build structures that are not only functional and aesthetically pleasing but also sustainable, minimizing their impact on the planet.

Indoor Environmental Quality

Sustainable architecture education delves deep into the realm of Indoor Air Quality (IAQ), emphasizing the importance of clean, healthy air within buildings. Students learn how to design spaces that facilitate adequate ventilation, filtration, and the mitigation of pollutants. The goal is to create indoor environments where occupants can breathe freely, devoid of harmful contaminants, a lesson drawn from research by Neda Mirzaei et al., (2020). Sustainable architecture education places a spotlight on thermal comfort. Students explore strategies for regulating temperature and humidity to ensure occupants feel comfortable year-round. This encompasses the design of efficient heating, ventilation, and air conditioning (HVAC) systems, as well as the use of passive design principles like adequate insulation and shading. The aim is to foster indoor environments where people can thrive, irrespective of external weather conditions, in alignment with the insights of Shu Fen Chou (2023). The infusion of natural daylight into indoor spaces is a core principle in sustainable architecture education. Students learn to harness the benefits of daylight, such as energy savings and enhanced well-being. This involves strategic placement of windows, skylights, and reflective surfaces to optimize natural light distribution. The result is indoor spaces that are not only energy-efficient but also promote productivity and occupant comfort, a concept reinforced by Shanta Pragyan Dash & Deepika Shetty (2020). Sound plays a pivotal role in indoor comfort. Sustainable architecture education acknowledges the significance of acoustic comfort. Students explore techniques for mitigating noise pollution and optimizing soundscapes within buildings. This encompasses the use of acoustic materials, spatial planning, and innovative architectural elements to create spaces where occupants can work and relax without disturbance. The objective is to design environments that foster concentration, relaxation, and overall well-being, as espoused by research from Ninunroihan Jehtae, Arita Hanim Awang, and Noraini Ahmad (2022). In essence, indoor environmental quality education within sustainable architecture empowers students to become stewards of well-being. They learn to create indoor environments that not only promote

health and comfort but also enhance the overall quality of life for occupants. This holistic approach ensures that future architects are equipped with the tools to design spaces that prioritize the well-being of both people and the planet.

Social and Cultural Considerations

Sustainable architecture education champions the art of community engagement. Students learn to actively involve the communities they serve in the design process. This entails conducting dialogues, surveys, and workshops to understand the unique needs and aspirations of the people who will inhabit the spaces they create. By involving communities, architects ensure that their designs are not only sustainable but also deeply rooted in the values and desires of the local population (Shanta Pragyan Dash & Deepika Shetty, 2020). Inclusive design is a core principle in sustainable architecture education. Students delve into strategies that ensure spaces are accessible to everyone, regardless of physical abilities. This involves considering elements like ramps, elevators, wider doorways, and tactile surfaces to create environments where inclusivity is not an afterthought but an integral part of the design process (Shu Fen Chou, 2023). Sustainable architects are guardians of cultural heritage. Students are taught to respect and celebrate the cultural identity of a place. This involves preserving and incorporating elements of cultural significance into their designs, ensuring that buildings resonate with the local heritage. Sustainable architecture becomes a bridge between the past and the future, a concept evident in the work of scholars like Neda Mirzaei et al (2020). Biophilic design is woven into the curriculum of sustainable architecture education. Students learn to integrate nature into their designs, whether through the incorporation of green spaces, natural materials, or the strategic use of daylight. This approach not only enhances the aesthetics of spaces but also fosters a profound connection to the natural world, a principle supported by Neda Mirzaei et al (2020). Sustainable architecture extends beyond aesthetics and functionality; it encompasses social impact. Students are equipped with tools for assessing the social consequences of their designs. They learn to evaluate how their projects may affect local communities, both positively and negatively, and make informed decisions to maximize the benefits while mitigating adverse effects emphasis by Shanta Pragyan Dash & Deepika Shetty (2020) and Shu Fen Chou (2023). In essence, social and cultural considerations in sustainable architecture education transcend the physical aspects of design. They equip students with the sensitivity and knowledge needed to create spaces that are not only environmentally sustainable but also socially and culturally enriching. This approach ensures that future architects are not just builders of structures but also stewards of thriving, inclusive communities.

Interdisciplinary Approach

In the realm of sustainable architecture education, the adoption of an interdisciplinary approach stands as a cornerstone. According to Ozge Erkan (2013), this approach transcends the boundaries of traditional architectural knowledge and encourages students to draw insights from an array of disciplines, including engineering, ecology, sociology, and economics. The goal is to foster a comprehensive and well-rounded understanding of sustainability and its profound applications in the realm of architecture (Shu Fen Chou, 2023). Sustainable architecture education places a strong emphasis on collaboration and cross-disciplinary learning. Students are encouraged to engage with experts from various fields to enrich their architectural perspectives. They learn that sustainability is not a singular pursuit but a collective endeavor that demands insights from diverse domains. By collaborating with experts in ecology, they gain an understanding of ecosystems and biodiversity. By working with sociologists, they explore the social dynamics that shape communities. By interacting with economists, they comprehend the financial implications of sustainable design. This collaborative spirit ensures that future architects are well-equipped to tackle complex, real-world challenges that extend beyond the boundaries of traditional architectural practice (Ninunroihan Jehtae, Arita Hanim Awang, and Noraini Ahmad, 2022). Sustainable architecture education propels students into the realm of research and innovation. They are challenged to question existing norms and explore innovative solutions. Through interdisciplinary research, students develop a nuanced understanding of sustainability's evolving landscape. This research-driven approach empowers them to pioneer new technologies, materials, and design strategies that push the boundaries of sustainable architecture. The integration of research and innovation ensures that sustainable architects are not just practitioners but also innovators who shape the future of sustainable design (Shu Fen Chou, 2023).

Research and Innovation

Sustainable architecture education champions environmental research as a means to unravel the complexities of sustainability. Students engage in studies that delve deep into ecological systems, resource management, and the impacts of human activity on the environment. Through research, they gain insights into the delicate balance between the built environment and the natural world. This scientific foundation equips them with the knowledge needed to make informed decisions that mitigate environmental harm and promote ecological harmony (Shu Fen Chou, 2023). A cornerstone of sustainable architecture education is the exploration of innovative materials and construction techniques. Students are encouraged to push the boundaries of convention, seeking out new

materials that are both environmentally responsible and technologically advanced. This includes delving into the realm of sustainable materials like engineered wood products, bio-based composites, and low-impact construction methods. By embracing innovation in materials and construction, students learn to design structures that are not only ecologically sound but also technologically cutting-edge (Shu Fen Chou, 2023). Sustainable architecture education places a strong emphasis on renewable energy integration. Students explore emerging technologies in the realm of solar, wind, geothermal, and other renewable energy sources. They learn to harness these energy sources to power their designs, reducing reliance on fossil fuels and contributing to a more sustainable energy future. Through research and innovation, they develop the skills needed to design buildings that generate their own clean energy and minimize their carbon footprint (Simay Özkan & Begum Gokdag-Ersozoglu, 2022). Sustainable architecture extends beyond the drawing board; it encompasses policy and advocacy. Students are encouraged to engage with sustainability policies, regulations, and advocacy initiatives. They learn how to navigate the evolving landscape of sustainability standards and advocate for policies that promote environmentally responsible design and construction. This advocacy-driven approach ensures that future architects are not just designers but also agents of positive change in the broader context of sustainable development (Veronika Kotradyová, 2022).

Professional Ethics and Responsibility

Sustainable architecture education places a strong emphasis on environmental stewardship. Students are taught that architects are not just designers of spaces but stewards of the environment. They learn to view each project as an opportunity to minimize ecological impact, protect natural resources, and promote environmental well-being. This sense of stewardship extends beyond the boundaries of individual projects, inspiring architects to become champions of sustainability in the broader context (Shu Fen Chou, 2023). According to Ninunroihan Jehtae, Arita Hanim Awang, and Noraini Ahmad (2022), Architects bear a responsibility not only to the environment but also to society and culture. Sustainable architecture education fosters social and cultural sensitivity in students. They learn to design spaces that respect diverse cultural traditions, enhance community well-being, and promote social equity. This sensitivity ensures that architectural solutions are not only environmentally sustainable but also socially and culturally enriching. A cornerstone of professional ethics in sustainable architecture is life cycle thinking. Students are trained to consider the entire lifespan of a building, from design and construction to operation and eventual demolition. This holistic perspective guides decision-making, ensuring that architects anticipate and mitigate long-term environmental and societal impacts (Ninunroihan Jehtae, Arita Hanim Awang, and Noraini Ahmad, 2022). Material selection is a moral endeavor in sustainable architecture. Students learn to make ethical choices when it comes to materials, considering factors like environmental impact, labor practices, and health and safety. They are empowered to seek out materials that align with their ethical principles, ensuring that their designs are not compromised by unethical sourcing or manufacturing (Shu Fen Chou, 2023). According to Shu Fen Chou(2023), Sustainable architecture education is a lifelong journey thus, students are encouraged to embark on a path of continuous professional development. They learn that staying current with advancements in sustainability, technologies, and design is not just a choice but a professional responsibility. This commitment to ongoing learning ensures that architects remain at the forefront of sustainable practice throughout their careers.

CONCLUSION

In conclusion, the identification and examination of key elements for sustainable interior architectural education illuminate a comprehensive framework that bridges the realms of design, environment, technology, culture, and ethics. These elements collectively form the cornerstone for preparing future interior architects to navigate the complex challenges of our ever-evolving world. Sustainable Design Principles underscore the importance of integrating environmental, economic, and social considerations into the very fabric of design. This ensures that interior architects are equipped to create spaces that not only delight aesthetically but also function as sustainable ecosystems. Environmental Awareness instills a sense of responsibility and stewardship, fostering an intrinsic understanding of the interconnectedness between design decisions and their environmental consequences. This awareness becomes a guiding compass in the journey toward sustainable interior architectural practice. Sustainable Materials and Construction strategies are pivotal in reducing the environmental footprint of interior architecture. By advocating for the use of eco-friendly materials and sustainable construction techniques, future professionals can contribute significantly to resource conservation.

Furthermore, the Integration of Renewable Energy and consideration of Life Cycle Assessment in design decisions empower interior architects to actively engage in energy-efficient and environmentally responsible design practices. Social and Cultural Considerations emphasize the importance of designing spaces that resonate with the communities they serve. By recognizing the cultural significance of design choices, interior architects can create spaces that honor diversity and inclusivity. Indoor Environmental Quality ensures that the spaces designed

by interior architects prioritize the health, comfort, and well-being of their occupants, making them not just visually appealing but also conducive to human flourishing. Research and Innovation are the engines of progress. Encouraging interior architecture students to engage in research and innovation fosters a culture of continuous improvement and keeps the field aligned with emerging trends and technologies. An Interdisciplinary Approach encourages collaboration and holistic thinking, acknowledging that sustainable interior architecture does not operate in isolation but is part of a broader ecosystem of design, engineering, and construction. Professional Ethics and Responsibility ground interior architects in a code of conduct that upholds the highest standards of integrity, responsibility, and accountability in their practice.

In essence, these key elements collectively prepare the next generation of interior architects to address the profound challenges of sustainability, imbuing them with the knowledge, skills, and ethical principles necessary to create spaces that enrich lives, harmonize with the environment, and contribute positively to the world. As sustainability continues to be an imperative in the field, nurturing these elements within the realm of interior architectural education ensures that the profession remains not only relevant but also a driving force for a better, more sustainable future.

COMPETING INTERESTS

The authors have no competing interests to declare.

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