

GUIDELINES FOR ASSESSING SUSTAINABLE HANDS-ON ARCHITECTURAL LEARNING PROGRAMS BASED ON A LITERATURE REVIEW

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The construction industry is a major contributor to the current global energy, environmental and socioeconomic crisis. Thus, approaching architectural work and studies with a sustainable perspective is essential for future architects. As a result, the current profile required for architects and the architectural education programs worldwide are changing. This study aims to develop a preliminary guideline for evaluating hands-on, neuro-education approach within architecture schools' training programs that incorporate sustainability principles. This literature review analyzes 76 studies published between 2012 and 2024 which discuss educational programs from the past twelve years to create a guideline that assess if architectural learning programs with theoretical and practical components cover the basic abilities regarding sustainability in terms of environmental impact and socioeconomic responsibility. The thematic analysis identified four dimensions relevant to sustainable architectural training: integration of sustainability into education, hand-on and real-life learning, socioeconomic responsibility and collective well-being, and environmental and technical competencies. Based on these findings, a preliminary guideline was developed to translate recurring themes from the literature into evaluative questions for architectural training programs.

Keywords: Architecture education, Sustainability assessment, Neuroeducation, Environmental responsibility.

1 THE CURRENT GLOBAL CRISIS

The world is facing an unprecedented energy, environmental, and socioeconomic crisis caused largely by the construction industry. This sector consumes over 40% of the global energy demand since 2009 (ONU 2024) as all the processes related to production, construction, and demolition require continuous use of coal, oil, and natural gas (Global ABC 2020) that emits large amounts of greenhouse gas emissions which increments the sector's footprint. Thus, the responsible use of materials and resources is essential to control the industry's environmental impact.

Moreover, the construction industry also widens the lack of working opportunities and economic inequality that can be easily reflected in the scarcity of formal constructions. Over 80% of the buildings worldwide are constructed without professional planning and with limited available resources (Vellinga 2018). This creates a serious socioeconomic disparity worldwide since there is almost nonexistent assistance of professional construction intervention where it is actually needed. As stated by Palero (2021), "the professional practice of architecture has served

the ostentation and conspicuous consumption of a minority of the population, which flaunts its conditions of luxury and comfort." This mercantile perception of the construction industry has hindered the implementation of actual environmental practices that could help eradicate the states of vulnerability among the population and improve humanity's well-being towards a more sustainable future.

2 SUSTAINABLE ARCHITECTURE

Sustainability is referred as a development model able to meet the needs of the present without compromising the ability of future generations to meet their own (Enel Group 2024). The implementation of this concept attempts to promote a sustainable relationship between humanity and the natural environment (González and Trebilcock 2012). As mentioned by Enel Group (2024) before, sustainability attempts to address this goal from two key angles: environmental improvement and socio-economic responsibility.

Architecture largely contributes to excessive use of resources and tends to restrict the access to dignified living, it is the profession's duty to change this outcome and it is a change that should start by the way architecture is taught.

3 EDUCATION IN ARCHITECTURE, SUSTAINABILITY, AND NEUROSCIENCE

Experts globally have heavily questioned current architecture practices and educational programs. The Institute for Advanced Architecture of Catalonia (IAAC) director in 2022, Daniel Ibáñez, declared: "I think that, as architects, we have been extremely self-absorbed, focused on the building, its aesthetics, its composition. What I am demanding is that we [...] try to recover a certain regional logic". Hence, it is clear that architecture practice and the abilities and knowledge necessary for architects to face the future are changing.

Modern architecture training programs must cover a sustainable approach to revert the negative impacts caused by the construction industry. Educational programs worldwide have emphasized developing advanced environmental strategies and highly developed sustainable design principles to create responsible, resilient, and sustainable environments. Even though this is a recent approach, it has gained much attention among universities and architectural firms that seek architects whose formation addresses technical and practical skills in environmental strategies to create sustainable designs (Boarin and Martinez-Molina 2022).

From today's teaching methods, the application of neuroscience reflected on experiential or active learning has shown positive results in the way students can learn practical knowledge for their professional lives. Within this field, neuro-education is understood as an educational approach informed by knowledge of cognitive processes and learning, in which theoretical information is reinforced through active, contextualized and multisensory experiences. Hands-on and real-life learning are therefore considered educational mechanisms through which students connect conceptual knowledge with practical situations. Neuroeducation is not treated as a separate sustainability criterion in the proposed guideline, but as the pedagogical rationale supporting the use of these active learning experiences. Combines psychology and cognitive science to create a more effective teaching method that requires hands-on (workshops with an active and direct involvement of its participants), real-life experiences and a multidisciplinary approach (Villacis and Ayarza 2020). This system states that the theoretical information that students are taught should be strengthened by experiencing real situations that allow them to use that knowledge practically. Thus, this teaching methodology seems to ensure dynamic and

responsible learning in terms of sustainability that would provide students with the necessary tools to face the profession.

Within this framework, hands-on activities, real-life situations, participation, adaptation, and knowledge transfer are considered observable characteristics of the proposed neuroeducation-oriented approach. These characteristics connect the learning process with the sustainability competencies identified in the literature and consequently inform the evaluation questions developed in Table 1.

Table 1. Sustainability evaluation for hands-on architectural training programs.
Source: Own elaboration.

Guidelines for Sustainable Hands-on Architectural Training Programs			
	Authors' Affiliation	Keywords	Specifications
Socioeconomic responsibility parameter	"It is imperative that architecture contributes to improving the living conditions of the world's majority population, providing sustainable and equitable solutions " – <i>Palero (2021)</i>	collective well-being, equity	• How does the program encourage collective well-being by improving the living conditions?
	"Postmodern criticism has emphasized the need to embrace complexity and uncertainty , proposing a professional profile that combines management and participation , with the ability to foresee hypothetical scenarios and being able to adapt, optimizing resources and maintaining a critical posture " – <i>Palero (2021)</i>	real life experiences, participation, adaptation, optimization	• What real-life situation did the program deal with? • What uncertain and complex situations did the program face? How did the students adapt to them in order to optimize resources? (ecological footprint)?
	Professor Mohammed Taleghani suggested that the implementation of sustainability in architectural education still presents some clear obstacles such as the lack of 'real' experts in this field, the persisting misunderstanding over the meaning of sustainability and the existence of ambiguous definitions of sustainable architecture [...] across the built environment professions. – <i>Boarin and Martinez-Molina (2022)</i>	knowledge transfer	• Which definition of sustainability was established according to the particularities of the context? • Which sustainability principals were applied during the program according to the definition established? • Was there any intervention of experts in terms of sustainable construction, being academics or local expertise on the field? • How were communities benefited by the construction knowledge exchange?
Environment parameter	"The professional profile should integrate technical skills , including drawing, structural analysis, and construction knowledge, to achieve the primary objective of optimizing material usage and maximizing benefits ." – <i>Boarin and Martinez-Molina (2022)</i>	technical skills	• Which technical resources were used (structural analysis, drawing, detailing, ecological footprint quantification) in order to understand materials and their application in order to optimize and maximize its benefits?
	Architectural firms are increasingly prioritizing hiring professionals with some sort of sustainable background from higher education degrees or through professional accreditations in international sustainable building standards, such as LEED®, WELL™, BREEAM®, Green Star, Passive House, etc. – <i>Boarin and Martinez-Molina (2022)</i>	accreditations	• Which sustainable international and/or local standards did the program followed?
	A "transmissive form of teaching and learning to a more transformative approach" [...] is to increase students' commitment to sustainability in their everyday life and as professionals. This approach will have a positive impact on how future built environment	further /additional abilities furthermore the program	• Which complementary pro-environmental behavior did students adopt during the daily practices of the program?

	professionals see and, therefore, design architectures that can foster pro-environmental attitudes and behaviors in building users” – <i>Palero (2021)</i>		
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4 CRITERIA SELECTION FOR THE LITERATURE REVIEW

Considering all previously mentioned and to create an evaluation for hands-on architectural training programs regarding sustainability, this study followed a structure literature review of a series of academic bibliographies that fulfilled the following criteria that helped frame the research:

- Publications no more than twelve years (2012-2024).
- Researches analyzing architectural training programs with a neuro-education approach: hands-on experiences.
- Publications that discussed at least one of the two main factors addressed by sustainability: environmental improvement and socio-economic responsibility.
- Investigations published on academic entities such as universities or research-verified databases.

With these criteria, a comparative analysis among seventy-six investigations was developed. Extracts from five publications that addressed the four principles of sustainability on architectural hands-on instruction were selected and contrasted. Based on this comparison, two publications were chosen as they fully met all criteria and offered a Hispanic and Latin American perspective on education, aligning more closely with the study's origins. These publications would be used as reference to establish a guideline to measure sustainability in architectural training programs.

5 RESULTS OF THE LITERATURE REVIEW

Seventy-six publications were reviewed, from which five were selected according to the established criteria concerning architectural training, hands-on experiences, and sustainability. The literature was compared to identify recurring themes that could inform the evaluation of sustainable hands-on architectural training programs. Four main dimensions emerged: (1) integration of sustainability into architectural education, (2) hands-on and real-life learning, (3) socioeconomic responsibility and collective wellbeing, and (4) environmental and technical competencies.

First, the literature identifies a gap between theoretical sustainability education and its practical application. González and Trebilcock (2012), in the review of 595 programs from 19 Latin American countries, found that only 7% explicitly incorporate sustainability into practical design training, while 45% address it theoretically and 48% had no sustainability content. Similarly, Boarin and Martinez-Molina (2022) reviewing over 500 studies, identified a disconnection between theoretical and practical components of sustainability education and highlighted the need for structured approaches incorporating service-learning and collaborative practical experiences. These findings support the integration of sustainability into practical architectural education rather than limiting it to theoretical instruction.

Second, the reviewed studies emphasize the importance of hands-on and real-life learning. Boarin and Martinez-Molina (2022) highlight practical construction knowledge and technical skills, while Palero (2021) emphasizes participation, collaboration, adaptation, and resource optimization when addressing complex and uncertain professional scenarios. Riaubienè *et al.* (2023), through a multigenerational study from 1997 to 2021, identify the changing professional role of architects and the increasing importance of sustainability and environmental

understanding. Together, these findings support evaluating whether training programs exposed students to real situations in which they apply knowledge, adapt to contextual conditions, participate in decision-making, and optimize available resources

Third, socioeconomic responsibility and collective well-being emerge as essential dimensions of sustainable architectural education. Palero (2021) emphasizes housing inequality, social responsibility, and the need for architects to contribute to improve living conditions. Combined with the curricular gaps identified by González and Trebilcock (2012), these findings indicate that sustainability education should address both environmental conditions and the social realities of the communities served. Therefore, equity, collective well-being, knowledge transfer, and community benefit are incorporated into the proposed evaluation.

Finally, the literature highlights environmental and technical competencies. Boarin and Martinez-Molina (2022) emphasize drawing, structural analysis, construction knowledge, material optimization, and the use of sustainable standards. Palero (2021) additionally emphasizes the development of pro-environmental attitudes and behaviors through transformative learning. These findings support assessing the technical resources, sustainable practices, material use, standards and additional environmental abilities developed through hands-on training.

5.1 Synthesis of the Findings

The thematic synthesis indicates that sustainable architectural education requires a connection between knowledge, practical experience, environmental responsibility, and socioeconomic responsibility. The literature consistently points toward the need to move from predominantly theoretical approaches toward educational experiences in which students participate in real-life situations, apply technical knowledge, respond to contextual challenges, and consider the effects of architectural decisions on both people and the environment.

These findings provide the basis for the preliminary guideline presented in Table 1. The guideline translates the recurring themes identified in the literature into questions that can be used to examine hands-on architectural training programs. The proposed four dimensions address collective well-being and equity, real-life experience and participation, socioeconomic responsibility and knowledge transfer, and environmental and technical competencies.

The synthesis also indicates that the proposed guideline should be understood as preliminary framework derived from the reviewed literature, rather than as a validated assessment instrument. Its effectiveness requires further application and evaluation in existing architectural training programs.

6 SUSTAINABLE HANDS-ON ARCHITECTURAL TRAINING PROGRAM GUIDELINE

The following guideline shown in Table 1 was developed in order to determine how modern architecture training programs with a hands-on and real-life experience approach concerning the necessary abilities master sustainable design.

7 CONCLUSIONS

The previous guideline represents a preliminary mechanism to assess the effectiveness of architecture hands-on, training programs to provide students the necessary tools to face the profession regarding the two key angles to achieve sustainability in the construction industry: social and environmental responsibility. This guideline's approach concerning these key aspects show the following:

- **Socioeconomic responsibility:** this training methodology promotes the creation of a solid socio-environmental consciousness on future architects. This perception allows professionals to face the uncertainty of upcoming construction scenarios, optimize the available resources and, with a real helping guide of professionals and local experts of sustainable development, design and build efficient project to improve living conditions where it is actually needed. This approach allows educational programs to change the architect's perception about their labor, introducing more fields of action and working opportunities while changing the mercantile perception of the industry.
- **Environmental improvement:** this approach enhances environmental practices as technical and applicable knowledge that seeks to improve the living standards of the population. It encourages architects to design projects that maximize the benefits for the collective well-being and promoting the implementation of sustainable practices within its users. This educative method ensures that the new architecture profiles acquire environmental habits which impact goes beyond the architectural practice, as they truly improve the natural environment through the application of daily actions enforced by practical architectural decisions on the built environment.

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