Mainstreaming Sustainability Education: A Case from Architecture Education in India

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Abstract

As a concept, the holistic approach to sustainability has three pillars as its foundation and standing - environmental protection, social responsibility, and economic practice (Jagatramka, Kumar, & Pipralia, 2020). All disciplines considered in formal education cater to the understanding and application of these three pillars of building sustainability, and so does architecture. This article aspires to establish and re-emphasize the need to reimagine the curricula to promote and cultivate a sustainable mindset through an illustration of architecture education in India. In order to achieve this objective, the top twenty-five Architecture Institutes ranked through the National Institutional Ranking Framework (NIRF) of the Ministry of Education, Government of India were used. The different Programs in the field of Architecture and Courses taught therein were considered and analyzed to understand the current status of architecture education of the top-ranked institutes contributing towards sustainable education goals (SDG4). The analysis suggests that though the curricula address the concepts and principles of sustainable education through architecture education in the NIRF top twenty-five HEIs, the number of Institutes/Universities offering the number of courses are not sufficient enough to holistically address and cater to the SDG requirements. This case, however, establishes the argument in favour of the important role education should play in fostering sustainability, and embedding concepts into curricula and practice.

Background

Living in the Anthropocene, it would be egregious to not acknowledge the growing adverse human impact on the Earth, and not address its dire consequences with utmost urgency, something that makes it imperative for society to develop "sustainability citizens" (Wals, 2015), who understand the complex world they inhabit, and can speak up and join hands for positive change (UNESCO, 2015). That's where education could and should play a decisive role. Education has

an undeniable potential to ensure that sustainability orientation is effectively embedded in peoples' awareness, attitudes, and actions. Higher Education Institutions (HEIs) in particular have a significant role to play in the implementation of education for sustainability. They can influence local communities and wider society by serving as models for sustainability and enhancing the capacity of people to make informed decisions and demonstrate responsible actions. Today, more than ever, HEIs are challenged to equip their students with a sustainability mindset and empower them with the competencies to act as change agents to address the sustainability needs of society and bring about the much-needed transformational change in the world. They are increasingly expected to undertake active measures to promote sustainable development, whether through redesigning curricula, rigorously crafting learning outcomes, fostering innovative pedagogies and campus initiatives, and aligning themselves with the UN's Sustainable Development Goals (SDGs).

UNESCO has been spearheading Education for Sustainable Development (ESD) since 1992, which has been explicitly recognised in the 2030 agenda for sustainable development, adopted by all United Nations member states in 2015. The agenda enumerated the seventeen SDGs and called for forging global partnerships to achieve better and more sustainable peace and prosperity for people and the planet. The seventeen SDGs are: as follows: 1. No Poverty, 2. Zero Hunger, 3. Good Health and Well-being, 4. Quality Education, 5. Gender Equality 6. Clean Water and Sanitation, 7. Affordable and Clean Energy, 8. Decent Work and Economic Growth, 9. Industry Innovation and Infrastructure, 10. Reduced Inequalities, 11. Sustainable Cities and Communities, 12. Responsible Consumption and Production, 13. Climate Change, 14. Life below Water, 15. Life on Land, 16. Peace Justice and Strong Institutions, and 17. Partnerships for the Goals (UNESCO, 2017).

The target 4.7 of the fourth SDG is to ensure that "all learners acquire knowledge and skills needed to promote sustainable development, including among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture's contribution to sustainable development" by 2030 (United Nations, 2015). This calls for mainstreaming sustainability education by evolving and offering

curricula, courses and contents that are aligned with sustainable development , implementing learning for the SDGs through modification in learning strategies, policies, programs, and ensuring that the body of knowledge on sustainable development created in the current times is effectively passed-on to future generations (Nevin, 2008). It's only when students are sensitized to the criticality and urgency of sustainable development, by way of thoughtful exposure to the diligently selected sustainability perspectives and practices right from the foundational to advanced level, they cultivate a sustainability mindset for a better tomorrow. The inclusion of sustainability in academic curricula not only enhances learners' awareness and attitudes toward sustainability (Sidiropoulos, 2014), but also the university's image and reputation. It is universally accepted that sustainable development education influences education content (Gatti et al., 2019), and is widely reinforced by numerous studies (Weiss and Barth, 2019). Therefore, it is not surprising that curriculum usually emerges as one of the important elements in almost all declarations for sustainability in higher education (Lozano et al., 2013), yet the adoption of sustainability in the curricula is limited to only some higher education institutions (Brodowski et al., 2019). Rider (2014) accentuated a wide gap between how education endeavours to address sustainability and SDGs and the work that needs to be done in this area. The gaps exist in higher education sustainable development policy, practice, and curriculum (Franco et al., 2019), which vary among educational fields (Brodowski et al., 2019).

This article asserts the inclusion of sustainability concepts in mainstream education (precisely all disciplines). With the inclusion and focus on interdisciplinary and multidisciplinary education coming to the fore, the educational space is undergoing changes, to a seemingly significant extent. Technology and Design are also facilitating this change. A good example is that of 'Architectural Humanities', which provides students the lens of different disciplines like History, Sociology, and Cultural Studies to facilitate a comprehensive understanding of issues at hand among the students (Santini, 2020).

The illustration discussed in the article draws from the discipline of Architecture. The rationale for the selection of this discipline is critical to the understanding of the main argument. The field of Architecture is related to different disciplines,

such as Sociology, Psychology, and Physics (Gucyeter, 2016) among many others. Architecture, as defined by Gucyeter (2016) is a "unique discipline that facilitates spatial solutions for human needs and has a fundamental responsibility to ensure a sustainable built environment...as a combination of creativity, scientific knowledge and technological innovation... Essentially a contested concept with a multitude of approaches, and sustainability is considered vital for architecture discipline."

Illustrative Case in Point: Sustainability Programs in Architecture

The Brutland report to the World Commission (United Nations) in 1987 defined sustainability as, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This is a movement about not only "protecting the interest of future generations" but also of the "earth's capacity to regenerate". This can be done by "integrating the principles, values, and practices of sustainable development into all aspects of education and learning" (Nevin, 2008). As a concept, the holistic approach of sustainability has three pillars as its foundation and standing – environmental protection, social responsibility, and economic practice (Jagatramka, Kumar, & Pipralia, 2020). All disciplines considered in formal education cater to the understanding and application of these three pillars of building sustainability, so does architecture.

Architecture is a popular discipline in contemporary times seeing enormous growth globally, and also among the Indian HEIs. It plays an important role in informing practices and policies of our times (see Sustainable Foundations: A Guide for Teaching the Sustainable Development Goals by the Manitoba Council for International Cooperation, 2020); in shaping up the civilization, infrastructure, and societies of modern times; and helping us learn from the past. Though there are challenges in integrating sustainability concepts into the curricula, the HEIs can contribute towards building sustainable societies and providing a base for many disciplines to appreciate and incorporate the principles and practices of sustainability in their respective curricula. Researchers have demonstrated the

role architecture can play as a discipline in teaching and fostering the concept of sustainability. For example, examining the place of sustainability in architecture education (Gucyeter, 2016); how architecture can play the lead role in the preservation of resources (Wright, 2003); consistent study and critical evaluation of concepts in architecture and their effect on society (Durmus, 2012); 'culture and social traditions' in the context of built environments and people (Darus, et al., 2009); sustainability, efficiency, and affordability; and the role and importance of vernacular architecture (Jagatramka, Kumar, & Pipralia, 2020).

Globally, Architecture is one discipline "responsible to envisage the built environment that should respond to the ecological biodiversity" through sustainable designs (Almeida, 2020). Many courses are recognized by UNESCO and encouraged as part of ESD. In India, the Government constituted the Council of Architecture (CoA) in the year 1972 "under the provisions of the Architects Act, 1972, enacted by the Parliament of India, which came into force on 1st September 1972. The Act provides for registration of Architects, standards of education, recognized qualifications and standards of practice to be complied with by the practicing architects". As of 2015, 423 institutions impart architectural education and give recognized degrees by the CoA, India. These include various NITs, IITs, autonomous institutions, and Universities/Deemed to be Universities are among them (CoA, as cited in the reference section). The Council prioritizes sustainable development-related concepts like "energy conservation, ecology, environmental pollution, urban renewals, rural settlements, and economic development at different levels"; and subjects like "Building Services and Equipment, Architectural History, and Climatology" in the recommended curricula (Vaish, 2016). The Council has mandated 70% of the recommended courses and kept 30% as an open slots to provide some room for customization.

Despite the growing interest, the concept of sustainability is subtly contested within the discipline. Santini (2020) in her research article discusses various reasons at length for the lack of prominence of sustainability concepts in architecture curricula, for instance, the fragmented and limited approach of certifications to sustainability, overlooking other problems to resource depletion, lack of consideration for vernacular architecture and its possible harmful effects, besides others.

Research Objective:

This article aspires to establish and re-emphasize the need to reimagine the curricula to promote and cultivate a sustainable mindset through an illustration of the architecture education in India.

Method:

In order to achieve this objective, the top twenty-five Architecture Institutes ranked through the National Institutional Ranking Framework (NIRF) of the Ministry of Education, Government of India were used. The best-ranked universities are known to have a sustainable vision towards establishing a culture of sustainability (Salvioni et al., 2017). The different Programs in the field of Architecture and Courses taught therein were considered and analyzed to understand the current status of architecture education of the top-ranked institutes contributing towards sustainable education goals (SDG4). The websites of the listed Institutes were reviewed to tabulate the information. Where the information was not available, Institutes were contacted to get the information. Some Institutes reverted and some didn't.

The listed institutional websites and other referred websites (for example, NIRF) are all available in the public domain for free access. The email written to the contacted institutions duly informed them about the nature of our request and that the data was required for our research study to be considered for publication. Thus, data obtained through public information or through institutions has been used for analysis and that which was not obtained through the proper channel was not considered for the study.

Analysis:

The data obtained has been analyzed for the information obtained through websites and correspondence with the respective HEIs. Table 1 depicts Programs Levels at which the related programs are offered in the top twenty-five Institutes (NIRF – India Rankings, Architecture 2021), and Table 2 depicts Programs, Courses,

and Course Type related to Sustainability in these HEIs. The tables are followed by their detailed analysis.

Table 1: Showing Programs Offered at Program Levels addressing Sustainability related Programs in the top twenty-five Institutes (NIRF – India Rankings, Architecture 2021)

S. No.	Institution	Program Name	Program Level
1	Indian Institute of Technology, Roorkee	None	None
2	National Institute of Technology, Calicut	None	None
3	Indian Institute of Technology, Kharagpur	Architecture and Regional Planning – Sustainable Built Environment	PG
4	School of Planning and Architecture, New Delhi	Master of Planning with specialization in Environmental Planning	PG
		Master of Architecture in Architecture Conservation	PG
5	Centre for Environmental Planning and Technology University	Master of Conservation and Regeneration	PG
6	School of Planning and Architecture, Bhopal	Master of Architecture Conservation	PG
		Master of Planning in Environmental Planning	PG
7	National Institute of Technology, Tiruchirappalli	Master of Architecture in Energy efficient and Sustainable Architecture	PG
8	School of Planning & Architecture, Vijayawada	Master of Architecture (Sustainable Architecture)	PG
		Master of Architecture (Architectural Conservation)	PG
		Master of Environmental Planning and Management	PG
9	Indian Institute of Engineering Science and Technology	None	None
10	Jamia Millia Islamia	None	None
11	College of Engineering Trivandrum	Master of Architecture in Environmental Design	PG
12	Lovely Professional University	None	None
13	Aligarh Muslim University	None	None
14	Birla Institute of Technology	None	None
15	BMS College of Architecture	None	None
16	Chandigarh University	None	None
17	Visvesvaraya National Institute of Technology	None	None
18	Faculty of Architecture, Manipal Academy of Higher Education, Manipal	None	None

S. No.	Institution	Program Name	Program Level
19	Thiagarajar College of Engineering	None	None
20	Maulana Azad National Institute of Technology	None	None
21	Chitkara University	None	None
22	Anna University	None	None
23	National Institute of Technology, Hamirpur	Master of Architecture in Sustainable Architecture	PG
24	Shri Mata Vaishno Devi University	None	None
25	M. G. R. Educational and Research Institute	None	None

Table 1 shows the top twenty-five Universities/Colleges/Institutes according to the 2021 NIRF ranking in the discipline of Architecture. The table demonstrates the number and nature of Programs offered by these HEIs that are directly related to sustainable development, which can aid establish the role that education provides in fostering sustainability (as per SDG 4). Most of these Universities/Institutes are offering either two (for example - School of Planning and Architecture, New Delhi; School of Planning and Architecture, Bhopal) or one Program (for example - Centre for Environmental Planning and Technology University; National Institute of Technology, Tiruchirappalli; College of Trivandrum; and National Institute of Technology Hamirpur). The School of Planning and Architecture, Vijayawada offers three Programs.

It is evident from the table that only eight Institutes offer specific programs dedicated to sustainability out of twenty-five. Ranked in third place, IIT Kharagpur will offer one related program that too in the future, which will be "Architecture and Regional Planning – Sustainable Built Environment".

Interestingly, all these Programs are offered at the Post Graduate (PG) level and there is no Program related to Sustainable Development offered at the Under Graduate (UG) level. In addition, the programs that are offered do not seem to cover the entire spectrum of sustainability concepts and practices. Further, the top two Institutes do not offer any specific program dedicated to sustainability.

S.No.	Institution	Program Name	Program Level (PG/UG)	SDG–4 centered Course Name	Semester	Nature of the Course (Core/ Elective)
1.	Indian Institute of Technology, Roorkee	Bachelor of Architecture	UG	Introduction to Environmental Studies	I	Core
				Ethics and Self Awareness	I	Core
				Climatology in Architecture	II	Core
				Landscape Design and Site Development	IV	Core
				Society Culture and Built Environment	V	Core
				Sustainable Architecture	VII	Core
				Architectural and Urban Conservation	X	Elective
		Master of Architecture	PG	Ecology and Sustainable Development	I	Core
				Sustainable Built Environment	II	Core
				Energy and Sustainability	II	Elective
				Sustainable Materials and Techniques	II	Elective
				Policies and Regulations for Sustainability	II	Elective
				Architecture and Urban Conservation	II	Elective
		Master of Urban and Rural Planning	PG	Ecology and Sustainable Development	I	Core
				Rural Planning and Development	II	Core
				Environmental Planning	II	Elective
				Environmental Law and Economics	II	Elective
				Environmental Impact Assessment	II	Elective
2	National Institute of Technology, Calicut	Bachelor of Architecture	UG	Building Climatology & Solar Architecture	III	Core
				Environmental Studies for Architecture	III	Core
				Energy, Sustainability & Site Planning	IV	Core
				Sustainable Architecture	VIII	Elective
				Architectural Conservation	IX	Elective
				Environmental Impact Assessment	IX	Elective
		Master of Urban Planning	PG	Environmental Planning	II	Core
				Planning for Sustainable Development	II	Elective
				Environmental Impact Assessment	II	Elective
				Urban Design and Conservation	III	Elective
				Human Settlement and Climate Change	III	Elective
				Urban Renewal and Conservation	III	Elective
				Green City Planning for Sustainability	III	Elective
3	Indian Institute of Technology, Kharagpur	Bachelor of Architecture	UG	Environmental Science	I	Core
				Environmental Studies	III	Core
				Climatology and Solar Architecture	III	Core
		Architecture and Regional Planning – City Planning	PG	The Program is yet to start	TBC	TBC
		Architecture and Regional Planning – Sustainable Built Environment	PG	The Program is yet to start		
4	School of Planning and Architecture, New Delhi	Bachelor of Architecture	UG	Environmental Studies	I	Core
				Climate Responsive Design	II	Core
				Solar Active and Passive Systems	IV	Core
				Energy System and Renewables	V	Core
				Green Systems Integration	VI	Core
				Sustainable Urban Habitats	III onwards	Elective
				Environment Impact Assessment	III onwards	Elective
				Solar Design	III onwards	Elective
				Renewable Energy systems	III onwards	Elective
				Energy Simulations	III onwards	Elective
				Climate Change and Cities	III onwards	Elective
		Bachelor of Planning	UG	*Curriculum not available*		
		Master of Architecture in Architecture Conservation	PG	History and Theory of Conservation	I	Core
				Planning for Conservation	I	Core

				Integrated Urban Conservation	II	Core
				Conservation Philosophy	IV	Core
				Conservation Management	IV	Core
		Master of Urban Design	PG	None	None	None
		Master of Design (Industrial Design)	PG	Design for Sustainability	II	Elective
		Master of Planning with specialization in environmental plan	PG	*Curriculum not available*		
		Master of Planning with specialization in Housing	PG	*Curriculum not available*		
		Master of Planning with specialization in Regional Planning	PG	Housing and Environmental Planning	I	Core
				Climate Change and its Impact	II	Core
				Environment and Development	III	Core
		Master of Planning with specialization in Transportation Plan	PG	*Curriculum not available*		
		Master of Planning with specialization in Urban Planning	PG	Sustainable Planning and Development	II	Core
				Climate Resilient Urban Development	IV	Elective
		Master of Construction Engineering and Management	PG	*Curriculum not available*		
		Master of Landscape Architecture	PG	*Curriculum not available*		
5	Centre for Environmental Planning and Technology University	Bachelor of Architecture	UG	*Curriculum not available*		
		Master of Architectural Design	PG	Relating through concerns of Social, Cultural,	III	Core
				Architecture as Resources – Fundamentals of	I	Core
		Master of Conservation and Regeneration	PG	Structural Conservation	I	Core
				Architectural Conservation Studio	II	Core
				Ethics and Legislation	II	Core
				Case Studies in Conservation	II	Core
				Sustainability and Conservation	III	Core
		Masters of Architectural History and	PG	None	None	None
		Master of Landscape Architecture	PG	Field Ecology of Plants	I	Core
		Bachelor of Urban Design	UG	*Curriculum not available*		
		Master of Urban Planning	PG	*Curriculum not available*		
		Master of Urban Transport Systems	PG	*Curriculum not available*		
		Master of Urban Infrastructure	PG	*Curriculum not available*		
		Master of Urban Housing	PG	*Curriculum not available*		
		Master of Urban Design	PG	*Curriculum not available*		
6	School of Planning and Architecture, Bhopal	Bachelor of Architecture	UG	Ecology and Environmental Studies	I	Core
				Environmental Behavioral Studies	II	Core
				Climate Responsive Architecture	III	Core
				Energy Efficient Architecture	VII	Core
				Conservation	IX	Core
		Bachelor of Planning	UG	Ecology, Environment and Resource Development	IV	Core
				Sustainable Urban Development	V	Core
				Urban Renewal and Conservation	VI	Core
		Master of Architecture Conservation	PG	Authenticity and Integrity	II	Core
				History of Conservation	II	Core
				Heritage led Regeneration	II	Core
				Disaster Management of Cultural Resources	III	Core
				Conservation Practice in India and Abroad &	III	Core
				Global Practices for Heritage Studies	IV	Core
		Master of Architecture in Urban Design	PG	Ecology and Environment	III	Core
		Master of Landscape Architecture	PG	Landscape Conservation	II	Elective
				Wild Life Landscape and Management	II	Elective
				Green Buildings	II	Elective
				Energy Efficient Landscapes	III	Elective

			Environmental Impact Assessment	IV	Core
			Master of Planning in Urban and Regional Planning	PG	Housing and Environment	I	Core
		Master of Planning in Urban and Regional Planning	PG	Housing and Environment	I	Core
				Sustainable Planning Practices	II	Elective
				Disaster Mitigation and Management	III	Core
		Master of Planning (Environmental Planning)	PG	Housing and Environment	I	Core
				Environmental Planning Studio	II	Core
				Climate Informed Settlement Planning	II	Core
				Environmental Policy: Law and Governance	II	Core
				GIS applications in Environmental Planning	II	Core
				Environmental Impact Assessment and Monitoring	II	Core
				Environmental Planning Studio-II (Urban Sector	III	Core
				Green Infrastructure	III	Elective
				Natural Resource Management	III	Elective
				Biodiversity Conservation	III	Elective
				Environment and Society	III	Elective
				Ecological and Environmental Analysis	III	Elective
				Environmental Economics and Project Appraisal	III	Core
				Ecosystem Values and Management	IV	Elective
				Environmental Networks: Communication and	IV	Elective
				Technology and Environmental Planning	IV	Elective
		Master of Planning (Transport Planning and Logistics Management)	PG	Housing and Environment	I	Core
				Sustainable Mobility	III	Elective
7	National Institute of Technology, Tiruchirappalli	Bachelor of Architecture	UG	Environmental Science	I	Core
				Environment and Behaviour	IX	Core
				Environmental Control and Design Workshop	VIII	Elective
				Energy Efficient Buildings	IX	Elective
		Master of Architecture in Energy Efficient and Sustainable Architecture	PG	Energy, Environment and Buildings	I	Core
				Building Science and Sustainability	I	Core
				Solar Passive Architecture	I	Core
				Assessment of Built Environment	I	Core
				Building Energy Analysis Studio	I	Core
				Green Architecture	II	Core
				Energy Efficient Landscape Design	II	Core
				Statistics for Environmental Design	I/II	Elective
				Environment and Behaviour	I/II	Elective
				Environmental Lighting	I/II	Elective
				Natural Ventilation	I/II	Elective
				Healthy Buildings	I/II	Elective
8	School of Planning & Architecture, Vijayawada	Bachelor of Architecture	UG	Environmental Sciences	II	Core
				Climate and Built Form	III	Core
				Energy Efficient Architecture	VI	Core
				Architectural Conservation	IX	Core
				Landscape and Ecology	VIII	Elective
				Green Buildings and Rating systems	VIII	Elective
				Sustainable Architecture	IX	Elective
				Architectural Conservation	IX	Elective
		Master of Architecture (Sustainable Architecture)	PG	Building Physics and Sustainability	I	Core
				Environmental Codes and Energy Ratings	I	Core
				Resource Conservation and Efficiency	I	Core
				Smart Materials for Green Buildings	II	Core
				Waste Management	II	Core
				Eco Cities	II	Core
				People, Environment and Buildings	III	Core

				Eco sensitive Accessories and Green Materials	III	Core
				Traditional Wisdom and Sustainability Concepts	III	Core
				Energy Efficient Landscape	III	Core
		Master of Architecture (Landscape Architecture)	PG	Ecology, Ecosystem Analysis and Field Ecology	II	Core
				Energy Efficient Landscape	III	Core
		Master of Architecture (Architectural Conservation)	PG	Architectural Conservation Studio	I	Core
				Introduction to Conservation, History and		Core
				Planning and Conservation		Core
				Architectural Conservation Studio II		Core
				Conservation and Heritage Management		Core
				Historic Construction and Material Conservation		Core
				Architectural Conservation Studio III		Core
				Disaster Management of Cultural Resources		Core
		Bachelor of Planning	UG	Planning and Management of Green and Open	V	Core
				Environmental Planning and Management	V	Core
				Environmental Impact Assessment	VII	Elective
				Planning for Disaster Management	VII	Elective
				Climate Change and Cities	VIII	Core
		Master of Environmental Planning and Management	PG	Habitat and Environment Planning	I	Core
				Urban Environmental Planning Studio	II	Core
				Environmental Monitoring and Assessment Tools	II	Core
				Theory of Environmental Planning and Design	II	Core
				Environmental Economics	II	Core
				Ecological Footprints Analysis	II	Elective
				Planning for Healthy Cities	II	Elective
				Regional Environmental Planning Studio	III	Core
				Environmental Impact Assessment Techniques	III	Core
				Human Settlements and Climate Change	III	Elective
				Environmental Planning Thesis	IV	Core
				Environmental Justice and Professional Practice	IV	Core
				Environmental Law, Policy and Governance	IV	Core
		Master of Urban and Regional Planning	PG	Habitat and Environmental Planning	I	Core
				Human Settlements and Climate Change	III	Elective
		Master of Planning (Transportation and Infrastructure Planning)	PG	Habitat and Environment Planning	I	Core
				Transport and Environment	II	Core
9	Indian Institute of Engineering, Science, and Technology	Bachelor of Architecture	UG	Fundamentals of Ecology and Environmental	II	Core
				Climatology	IV	Core
10	Jamia Milia Islamia	Bachelor of Architecture	UG	None	None	None
		Master of Architecture (Architecture Pedagogy)	PG	Humanities and Built Environment	I	Core
		Master of Architecture (Building Services)	PG	EIA Natural Resources	I	Core
				Plumbing and Solar Water Heating	IV	Core
		Master of Architecture (Healthcare Architecture)	PG	None	None	None
		Master of Architecture (Recreational Architecture)	PG	Ecology and Environment	I	Core
				Designing with Nature I	II	Core
				Zoo Design and Eco-Tourism	II	Core
				Designing with Nature II	III	Core
		Master of Architecture (Urban Regeneration)	PG	Integrated Territorial Urban Conservation	II	Core
				Integrated Urban Eco System Management	II	Core
		Master of Architecture in Ekistics	PG	Environment and Management of Natural Resources	I	Core
11	College of Engineering, Trivandrum	Bachelor of Architecture	UG	Climate and Built Form I	III	Core
				Climate and Built Form II	IV	Core
				Environmental Science for Architecture	VIII	Core

		Master of Architecture (Urban Design)	PG	Site Planning and Ecology	I	Core
				Environmental Planning and Development	III	Elective
				Sustainable Settlement Planning	III	Elective
		Master of Planning (Housing)	PG	Environmental Planning and Development	III	Elective
				Sustainable Settlement Planning	III	Elective
		Master of Architecture in Environmental Design	PG	*Curriculum not available*		
12	Lovely Professional University	Bachelors of Architecture	UG	*Curriculum not available*		
		Bachelor of Planning	UG	*Curriculum not available*		
		Masters of Architecture	PG	*Curriculum not available*		
		Masters of Planning	PG	*Curriculum not available*		
13	Aligarh Muslim University	Bachelor of Architecture	UG	Environmental Studies	II	Core
				Climate and Design	III	Core
				Architectural Conservation	IX	Elective
				Sustainable Architecture	IX	Elective
		Master of Architecture	PG	Ecology and Sustainable Development	I	Core
				Architecture and Urban Conservation	II	Core
14	Birla Institute of Technology	Bachelor of Architecture	UG	Climatology	III	Core
				Environmental Studies	III	Core
				Architectural Conservation and Heritage	VI	Elective
				Energy Efficient Architecture	VII	Core
				Sustainable City Planning	VII	Elective
				Urban Ecology and Environmental Planning	IX	Elective
		Master of Urban Planning	PG	Urban Ecology and Environmental Planning	I	Elective
				Urban Regeneration and Conservation Techniques	I	Elective
				Sustainable City Planning	I	Elective
15	BMS college of Architecture	Bachelor of Architecture	UG	Climatology	III	Core
				Environment Responsive Architecture	IV	Elective
				Culture and Built Environment	VI	Elective
		Master of Architecture Habitat Design	PG	Heritage Habitat: Conservation and Renewal	I	Core
				Future of Habitat: Critical Issues	IV	Core
16	Chandigarh University	Bachelor of Architecture	UG	Climatology	III	Core
				Green building and Rating Systems	VII	Elective
				Sustainable Cities and Communities	IX	Elective
				Architectural Conservation	IX	Elective
		Master of Architecture	PG	Ecology and Natural Resources	I	Core
				Sustainable Energy Efficiency	II	Core
17	Visvesvaraya National Institute of Technology	Bachelor of Architecture	UG	Climate Responsive Architecture	II	Core
				Environmental Studies	III	Elective
				Green Architecture	III	Elective
				Barrier free Environmental Design	III	Elective
				Environment Behaviour Studies	IV	Core
				Architectural Conservation	VIII	Elective
		Master of Urban Planning	PG	Climate Change and Disaster Resilient Urban	Odd	Core
				Urban Climatology	Odd	Elective
				Ecology and Environmental Planning	Odd	Elective
				Methods in Sustainable Urban Planning	Even	Elective
				Urban Microclimate Studies	Even	Elective
18	Faculty of Architecture, Manipal Academy of Higher Education, Manipal	Bachelor of Architecture	UG	Environmental Science	I	Core
				Climatology and Lab	II	Core
				Sustainability (basic)	VII	Elective
				Sustainability	VIII	Elective

				Sustainability	X	Elective
				Sustainability	X	Elective
		Master of Architecture in Urban Design and Development	PG	Sustainable Development and Climate Change	I	Core
				Sustainability	I	Elective
				Environment and Behaviour	II	Elective
				Sustainability	II	Elective
				Sustainability	II	Elective
				Environment and Landscape Design	III	Elective
19	Thiagarajar College of Engineering	Bachelor of Architecture	UG	Climate and Architecture	III	Core
				Environment Behaviour Studies	IV and above	Elective
				Environment and Architecture	II and above	Elective
				Sustainable Architecture	IV and above	Elective
		Master of Architecture	PG	Climate Change Adaptation & Resilience	I	Core
				Urban Renewal & Conservation	II	Core
				Urban Ecology	III	Core
				Sustainable Water Management	II	Elective
20	Maulana Azad National Institute of Technology	Bachelor of Architecture	UG	Environment and Ecology	I	Core
				Climatology	III	Core
		Bachelor of Planning	UG	Ecology, Environment and Resource Management	IV	Core
				Urban Renewal and Conservation	VI	Core
				Human Settlements and Climate Change	VII	Core
				Green Infrastructure	VIII	Core
				Sustainable and Resilient Cities	VIII	Core
				Environment Impact Assessment	VIII	Elective
		Master of Planning in Housing	PG	Environmental Planning	I	Elective
				Energy Efficient Planning	II	Elective
				Climate Change and Human Settlement	II	Elective
				Ecology and Resource Development	III	Elective
				Sustainable Planning Practices	III	Elective
				Solid Waste Management	III	Elective
		Master of Planning in Urban Development	PG	Ecology and Resource Development	II	Elective
				Urban Conservation	II	Elective
				Environmental Planning	I	Elective
				Sustainable Planning Practices	II	Elective
				Solid Waste Management	II	Elective
				Solar Energy Systems	II	Elective
21	Chitkara University	Bachelors of Architecture	UG	*Curriculum not available*		
22	Anna University	Bachelor of Architecture	UG	*Curriculum not available*		
		Master of Architecture	PG	*Curriculum not available*		
		Master of Architecture in Landscape	PG	*Curriculum not available*		
23	National Institute of Technology, Hamirpur	Bachelor of Architecture	UG	Climate and Built Environment	III	Core
				Energy Efficient Architecture	X	Core
		Master of Architecture in Sustainable Architecture	PG	Sustainable Architecture Theory and Principles	I	Core
				Fundamentals of Ecology	I	Core
				Energy Efficient Architecture	II	Core
				Architectural conservation	I	Elective
				Eco Cities	II	Elective
24	Shri Mata Vaishno Devi University	Bachelor of Architecture	UG	Climatology	III	Core
				Environmental studies	VI	Core
				Green Buildings	VIII	Core
				Energy Efficient Buildings	IX	Elective
				Energy Footprint of Built Environment	IX	Elective

			Environmental Management	IX	Elective
			Architectural Conservation	X	Elective
25	M. G. R. Educational and Research Institute	Bachelor of Architecture	UG	Climatology	IV	Core
			Energy Efficient Architecture	V/VI	Elective
			Recycling and Waste Management	V/VI	Elective
			Sustainable Planning and Architecture	VII/IX	Elective
			Architectural Conservation	VII/IX	Elective
	Master of Architecture (Construction Project Management)	PG	None	None	None

Table 2: Showing Programs, Courses and Course Type related to Sustainability in the top twenty-five Institutes in India (NIRF – India Rankings, Architecture 2021)

Table two depicts the courses related to sustainability, which may either be Core or Elective; the Semester in which they are offered; and that can be mapped to the SDG4, within the architecture program.

It would be interesting to look at the analysis evident from the information mentioned in Table two. To reiterate, there are no seemingly particular Programs related to sustainability at the undergraduate level. Most of the NIRF top ranked Universities/Institutes offers only Bachelor of Architecture (B. Arch.), except four Institutes/Universities that offer Bachelor of Planning as well (School of Planning and Architecture, Bhopal; School of Planning and Architecture, Vijayawada; Lovely Professional University; and Maulana Azad National Institute of Technology).

Programs offered at the post-graduate levels are mostly in the areas of Planning (for example Master of Planning; Master of Urban and Rural Planning; Architectural and Regional Planning – City Planning; Architectural and Regional Planning - Sustainable Built Environment; Environmental Planning), Architecture (for example Landscape Architecture; Master of Architecture in Energy Efficient and Sustainable Architecture; Master of Architecture in Ekistics; Habitat Design), Conservation (for example M. Arch. in Architecture Conservation; Master in Conservation and Regeneration), Design (for example Urban Design and Development; Environmental Design, Habitat Design), Transport (for example: Urban Transport Systems; Transport Planning and Logistic Management), Infrastructure (for example Urban Infrastructure), and Housing (for example Urban Housing). Jamia Milia Islamia, ranked at number ten offers several interesting M. Arch. Programs like Architecture Pedagogy, Building Services, Health Care Architecture, Recreational Architecture, and Urban Regeneration. This description

envisages that though there are some interesting Programs, not all Programs: a) address all the ESD requirements, b) are commonly offered in all Institutes or Universities; and c) have a lot of variation in how the Program is designed. It was also observed that the curriculum of some Universities, which are ranked and have Programs that can contribute to sustainable education curriculum, was not accessible. There was no information on the website and the authorities did not respond when contacted. The absence of that information can be a limitation of this study.

The table suggests around 64 Core Courses and 49 Electives on Sustainability and related concepts at the undergraduate level Programs whereas around 106 Core Courses and 80 Electives at the post-graduate level Programs. Courses offered by the different Schools of Planning and Architecture (SPA) stand out as the most contributing towards Sustainable architecture education in India's top ranked [for example – SPA New Delhi (UG Core=5, Elective=6; PG Core=9, Elective=2); SPA Bhopal (UG Core=8, PG Core=19, Elective=21); SPA Vijaywada (UG Core=7, Elective=6; PG Core=32, Elective=8)]. These are only examples from the analysis of the available data. These findings are therefore, indicative in nature. Most of the Institutes are offering a minimal of 5-6 sustainability-centered courses.

Courses offered at the undergraduate level can be grouped using sustainability-centered keywords (in order of prominence) such as Environment (for example Introduction to Environment Studies; Environmental Studies for Architecture; Environment and Behavior; Environment Impact Assessment), Climate (for example: Climatology in Architecture; Climate and Design; Climate and Built Form), Sustainability (for example Sustainable Architecture; Sustainability; Sustainable and Resilient Cities); Conservation (for example Architectural Conservation; Urban Renewal and Conservation), Energy (for example Energy, Sustainability, and Site Planning; Solar Active and Passive Systems; Energy Systems and Renewables; Energy Simulations; Energy Efficient Architecture; Energy Footprints of Built Environment), Green (for example Green Architecture, Green Infrastructure, Green Systems Integration), Design (for example Landscape Design and Site Development; Barrier Free Environmental Design; Solar Designs; Climate Responsive Designs), Ecology (for example Landscape and Ecology; Urban Ecology and Environmental Planning; Fundamentals of Ecology and

Environmental Pollution; Ecology, Environment, and Resource Management; Recycling and Waste Management;), and Built (for example Society, Culture, and Built Environment).

One course worth mentioning is Ethics and Self Awareness offered in the first Semester as a core paper at IIT Roorkee. This is the only Institute (as per the availability and analyzed data) offering this course. The course is specially mentioned because of the conceptual significance it holds in sustainable education. All social, cultural, and economic ideas can be fairly applied only through a good intention and just act. What makes things work in the long run are values, and anything devoid of value will not hold in the longer run. Therefore, this type of course needs to be a part of such curricula mandatorily.

Courses offered at the **post-graduate level** can be grouped using sustainability-centered keywords (in order of prominence) such as:

Conservation (for example Architecture and Urban Conservation; Urban Renewal and Conservation; Architecture Conservation Studio; History and Theory of Conservation; Integrated/Territorial Urban Conservation; Conservation Philosophy; Structural Conservation; Conservation Practice in India and Abroad & Professional Training; Global Practices for Heritage Studies; Wild Life Landscape and Management; Biodiversity Conservation; Heritage Habitat: Conservation and Renewal; Future of Habitat: Critical Issues).

Planning (for example Theory of Environmental Planning and Design; Environmental Planning; Regional/Urban Environmental Planning Studio; Sustainable Planning and Development; Planning for Healthy Cities; GIS Application in Environmental Planning; Technology and Environmental Planning; Cite Planning and Ecology; Environmental Planning and Development; Methods in Urban Sustainable Planning).

Environment (for example Environmental Economics; Environmental Law and Economics; Environment and Behavior; Environment Impact Assessment; Housing and Environment, Environment and Society; Environmental Justice and Professional Practice; Environmental Codes and Energy Ratings).

Ecology (for example Ecology, Ecosystem Analysis, and Field Economics; Ecological Footprint Analysis; Ecology and Sustainable Development; Ecology and Resource Development; Ecosystem Values and Management; Ecology and Environmental Analysis; Eco Cities; Eco sensitive Accessories and Green Materials; Integrated Urban Eco System Management; Ecology and Natural Resources).

Climate (for example Human Settlement and Climate Change; Climate Change, Adaptation and Resilience; Climate Change and its Impact; Climate Change and Disaster Resilient Urban Infrastructure; Urban Climatology; Architecture as Resources – Fundamentals of Climate Responsive Architecture; Climate Informed Settlement Planning; Urban Microclimate Studies).

Energy (for example Energy Efficient Architecture/Landscapes; Energy, Environment and Buildings; Solar Passive Architecture; Building Energy Analysis Studio; Energy Efficient Planning; Solar Energy Systems).

Sustainability (for example Sustainable and Resilient Cities; Sustainability and Conservation; Sustainable Architecture: Theories and Principles; Sustainable Mobility; Building Services and Sustainability; Sustainable Development and Climate Change; Sustainable Water Management).

Resources (for example Disaster Management of Cultural Resources; Natural Resource Management; Waste Management; Environment and Management of Natural Resources).

Green (for example Green Buildings; Green Architecture, Green Infrastructure, Natural Ventilation).

Built (for example Sustainable Built Environment; Assessment of Built Environment; Healthy Buildings; People, Environment, and Buildings; Humanities and Built Environment).

Design (for example Design for Sustainability; Designing with Nature; Environment and Landscape Design).

and

Policies (for example Policies and Regulations for Sustainability; Environmental Law, Policy and Governance).

Some unique courses worth mentioning are: *Relating through Concerns of Social, Cultural, Economic* (Semester III) offered by Centre for Environmental Planning and Technology University. This title covers the entire spectrum of the sustainability concept. Centre for Environmental Planning and Technology University also offers *Ethics and Legislation* (Semester II) and *Field Ecology of Plants* (Semester I). School of Planning & Architecture, Bhopal offers *Authenticity and Integrity* (Semester II) and School of Planning & Architecture, Vijaywada offers *Traditional Wisdom and Sustainable Concepts* (Semester III). These are all very relevant and significant concepts taught as core courses. However, it is important to note that only these respective University/Institute offers these courses (their frequency in the table is only 1).

The top three Programs from the top three Institutes do not seem to offer programs specifically catering to sustainability. Amongst those who do offer, the top three would be **(Table 2)**: Master of Architecture in Architecture Conservation, from the School of Planning and Architecture, New Delhi (NIRF ranking 4). SPA, New Delhi also offers another program - Master of Planning with specialization in Environmental Planning, but its curriculum is not available. Next, the Centre for Environmental Planning and Technology University with the Program - Master of Conservation and Regeneration; and further next, the School of Planning and Architecture Bhopal, which offers two programs related to sustainability and the school of architecture - Master of Architecture Conservation and Master of Planning in Environmental Planning.

The data as mentioned in the above table suggests that though the curricula address the concepts and principles of sustainable education through architecture education in the NIRF top twenty-five HEIs, the number of Institutes/Universities offering the number of courses is not sufficient enough to holistically address and cater to the SDG requirements. This case, however, establishes the important role education can play in fostering sustainability, embedding concepts into curricula and practice and the gap that needs to be filled in doing so.

Discussion and Conclusion

Nelson Mandela was of the view that "Education is the most powerful weapon which you can use to change the world". There is no denying that education can play a central role in fostering a sustainability mindset, and HEIs can act as a catalyst for the achievement of the SDGs. The existing body of knowledge is well placed to guide HEIs in adopting a sustainability curriculum (Weiss and Barth, 2019).

Despite evidence to the contrary, as demonstrated by the illustrated case of architecture education in India, the curricula, courses, and content HEIs are not remotely attuned to sustainable development. The programs offered in this discipline are faintly aligned with the SDG requirements, the number of elective courses that specifically cater to the SDG is meagre, and the sustainability-specific core courses are almost inexistent. To reiterate and as evidenced in the illustrated case, the concept of sustainability is subtly contested within architecture discipline, which perhaps can be attributed to the lack of prominence of sustainability concepts in the architecture curricula, for instance, the fragmented and limited approach of certifications to sustainability, overlooking the problems of resource depletion, inadequate consideration of vernacular architecture and its possible harmful effects, besides others (Santini, 2020).

HEIs, particularly in the architecture education, need to reimagine their programs and pedagogical praxis to promote learning for the SDGs. It is imperative that they, with intense earnestness, raise and respond to the question of 'what should their students learn? It is incumbent on them to adequately emphasize values and ethics in the classroom, which hitherto has been ignored (Corrigan, Dillon, & Gunstone, 2007) perhaps for want of encouraging policy frameworks (Wals, 2015). The CoA may like to reconsider the way it prioritises and embeds sustainability concepts in its recommended courses, which constitute 70% of the overall curriculum.

As the first step towards achieving the herculean task of mainstreaming sustainability education, HEIs, specifically the ones associated with the architectural space, must evolve their curricula around the cross-cutting key competencies and learning objectives for sustainability that are relevant to each

and all SDGs (UNESCO, 2017). The cross-cutting key competencies are considered important for learners of all ages worldwide and are perceived to be instrumental in achieving sustainable development. The table below enumerates and explains the key competencies.

Key competencies for sustainability (UNESCO, as cited in the reference section)

Systems thinking competency:	The abilities to recognize and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty
Anticipatory competency:	The abilities to understand and evaluate multiple futures – possible, probable and desirable; to create one's own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes
Normative competency:	The abilities to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions
Strategic competency:	The abilities to collectively develop and implement innovative actions that further sustainability at the local level and further afield.
Collaboration competency:	The abilities to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving.
Critical thinking competency:	The ability to question norms, practices and opinions; to reflect on own one's values, perceptions and actions; and to take a position in the sustainability discourse.
Self-awareness competency:	The ability to reflect on one's own role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.
Integrated problem-solving competency:	The overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solution options that promote sustainable development, integrating the abovementioned competences.

A word of caution is in order here, though. The concept of competence when reduced to piecemeal behaviours and their corresponding indicators, can overly promote prescriptions of behaviours over the active engagement that fosters learning to know, critique, make change, to care, and to be (Wals, 2015). The SDG specific learning objectives are another important consideration that must be

pursued with the cross-cutting key sustainability competencies. It's important that HEIs examine what key competencies they are enabling, in addition to the specified learning objectives for the SDGs relevant to them. It's equally important that they adopt the relevant learning objectives in totality i.e., they must consider all three domains viz., cognitive, social-emotional and behavioural, where "the cognitive domain comprises knowledge and thinking skills necessary to better understand the SDG and the challenges in achieving it. The socio-emotional domain includes social skills that enable learners to collaborate, negotiate and communicate to promote the SDGs as well as self-reflection skills, values, attitudes and motivations that enable learners to develop themselves. The behavioural domain describes action competencies" (UNESCO, 2017). HEIs must make provision for the assessment of the adopted learning objectives to ascertain whether their curricula, programs, and courses are contributing towards the achievement of the SDGs or not.

This article enumerates the importance of curricula in furthering the cause of sustainability education, which is challenged by a contrary belief that says that sustainability, being an ill-defined and ill-structured concept, cannot be taught. "Teachers can at best create environment that are conducive to the exploration of sustainability issues around climate change, poverty, food security, biodiversity", hence teaching sustainability is more of an educational design challenge (Wals, 2015). Hence, it becomes imperative for HEIs to exercise due care while selecting the topics, methods and approaches for each learning objective of the relevant SDGs. Creating fieldwork projects to develop hands on experiential based learning of sustainable concepts and practices, and sustainability related extracurricular activities can be embedded into the curriculum.

The mission howsoever elusive should not deter the stakeholders' weather policymakers, educational institutions, or educators to synergise and evolve strategies, policies, programs, curricula, and courses to create awareness and trigger actions for achieving sustainable development.

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