Article

Collaborative learning experiences in a changing environment. Innovative educational approaches in architecture.

Ernesto Antonini [1,*], Jacopo Gaspari [1] and Cristina Visconti [1]

[1] Department of Architecture, University of Bologna Alma Mater Studiorum;

* Correspondence: ernesto.antonini@unibo.it

Abstract: The sense of uncertainty and fragility due to the effects and magnitude of global challenges we are facing (from pandemic circumstances to climate change impacts) requires – much more than in the past – the capacity to generate a visionary and forefront design approach in the young generations aiming at stimulating their reaction attitude rather than providing consolidated tools from past conditions that no longer exist or will rapidly evolve. Within this general framework, we have investigated the effectiveness and impacts of experienced-based methods of learning and innovative educational tools in architecture aimed at shaping expertise in which the environmental dimension and the climate-change challenge dialogues with the context's complexity in terms of socio-cultural dynamics, real potentialities and constrains, addressing their transdisciplinary trajectories. The paper analyses 5 international pioneering teaching experiences that provide the opportunity to understand the outcomes of collaborative and experiential learning processes in which the educational activities leverage a dialogue between diverse communities (academia-citizens-policy-makers-practitioners). The study outcomes show that shifting the pedagogical paradigm towards in-field-experience-based models can improve the awareness of future practitioners for climate implications of architectural design, implement their analysis and project skills while triggering processes of knowledge transfer and co-production at community level, and allow them to better address the societal and cultural issues involved within decision making.

Keywords: critical pedagogy; experiential learning; co-production

1. Introduction

The current multifaceted crisis has highlighted again the close entanglement of the Earth system with its human inhabitants. The pandemic spread generated further societal, health and economic pressures that challenge our responsibilities in creating harmful conditions, such as climate change, rapid loss of biodiversity, growing inequalities, and loss of resilience to deal with uncertainty [1]. Scientific evidences point out how the human actions are determining the Anthropocene scenario of planet Earth, drastically contributing in climate change and damaging biosphere [2] that are intertwined as well with social, economic and cultural dimensions [1] in a complex interplay of interdependencies [3]. Unexpected natural, political, economic and health events jointly with unforeseen societal responses trigger a reproduction of uncertainties in several domains at multiple levels [4]. This requires a renovated responsive capacity in planning, design and living our built environment. The interplay between human development and biosphere trajectories cannot be ignored by future generations of architects and planners that are called to contribute in generating a new vision, by translating key words like sustainability and resilience in design approaches capable to deal with complexity [5]. This perspective strictly matters the architectural education and pushes to overcome consolidated models, shaped on the past conditions, which appear no longer suitable.

Responsive educational practices are needed to stimulate the capacity to apply adaptive and context-based approaches and to seek for social-aware and climate-responsible solutions [6, 7]. The adaptive approach is an iterative evidence-based attitude toward the problem the design action is facing with, in order to both manage the learning process about its dynamics and develop, trial and adapt strategies to deal with them [8].

Although the sustainability has increased prominence in architectural curricula, as showed by the number of international events, commissions and study programs on the topic [9], several issues and limitations are still open [10,11].

The need to shift architectural education towards a more socially and ecologically responsible and informed vision is fueling a wide debate, to which scholars [12], students and professionals contribute, often supporting radically critical positions. Several British Architecture Schools launched the Architecture Education Declares campaign with an "Open Letter to the Architectural Community: A Call for Curriculum Change" [13]. A global campaign has been launched in 2019 under the umbrella of Architects Declare to call for an engagement on the responsibility of architects to act in coping with climate change [14]. The main criticism is that the architectural education system tends to protect its "business as usual" model even when it applies sustainability approaches, thus perpetrating the image-based architecture as a value [15, 16] and the Archistar worshipping [15, 17].

Multiple voices agree on the importance of an overhaul of architectural curriculum in order to equip students with an integrated understanding on the relation between socio-ecological dynamics, architecture and planning [6]. Although this, there is no consensus on the nature of the gap which is detaching architectural pedagogy from reality, thus both the diagnosis and prognosis of the problem are still unfixed [15,17,18]. Two main strands can be identified within the debate on the need that architectural education must better cope with a changing environment. These two schools of thought adopt differently nuanced epistemological positions on the role that architecture and planning can cover in responding the socio-ecological crisis caused by both anthropogenic and non-anthropogenic actions.

Based on evidences that built environment has enormous impacts on resource depletion and environmental dynamics - such as climate change- one of these position postulates an eco-friendly and eco-efficient built environment. Referring to UN HABITAT data, cities indeed consume 78% of the world's energy and produce more than 60% of greenhouse gas emissions, even if they account for only 2% of the Earth's surface [19]. Since housing absorbs about 18% of total energy end-use in developed countries [20], residential sector is the major source of CO_2 emissions [21, 22]. According to Andric et al. [23], this provides an evidence of the architecture implications on climate change. Implementing models for high-performance and environmental responsible buildings thus emerges as an urgent response to be provided, reducing the energy [23] and natural resources consumption along the whole building's life-cycle [24]. This approach frames a vision of ecological modernization based on advanced technical solutions and compelling "green" lifestyles narratives, that often overlook the social dimension the topic involves [25, 26]. As technological solutions are believed to be effective in addressing environmental problems, they emerge as the primary means by which to address the impacts of climate change [27,28].

A second orientation, instead, mainly takes inspiration on the role that architecture has in shaping the relation between human, nature and culture managing "the assemblages of habit and settlement that we call societies" [29]. To cope with a changing environment, architecture have to inquiry about the models that produced the Anthropocene, not assuming it as something of pregiven or inherited, but as a multi-disciplinary, multi-scalar,

and multi-centered reality to be addressed in its complex and fragile multiple dynamics [29]. Since the boundaries between culture and nature are becoming more and more blurred [30], architecture must leverage on its intrinsic capacity to transform not only the spatial dimensions, but also the socio-environmental ones [29, 31]. According to this approach, the sustainable architecture definition must be reconsidered, assuming that sustainability is a controversial concept [26, 32-34]. Guy and Moore extensively debated on how sustainability can be conceived as a social construct more than a universal framework to solve the environmental degradation and social injustice [35]. They foster a critical thinking on what sustainable architecture can mean, by exploring "the ways in which individuals, groups, and institutions embody widely differing perceptions of what environmental innovation is about". This means to embed contextual knowledge, critical pluralism and participatory design in architecture education [35, 36]

1.1. Scope

The above-mentioned tendencies can be also observed within the education pathways, as two different learning models: problem-solving oriented one – often expressing the trust in the technological response and capacity and complexity driven one – where responses are shaped by confronting with criticalities, fragilities and conflicting interests of local conditions [36-37]. Within this context, the paper aims to discuss the effectiveness of some experiences that integrate sustainability and resilience within the architecture education curricula, by adopting a critical learning praxis as experiential learning model [38-40]. The study explores the implications of this approach and its tools in educational pathways as capable to consider environmental dynamics in its interconnection with social, cultural, political and economic ones and in their integration within the design of physical assemblages of the built environment.

The paper first reports (Par. 2) the main barriers and limitations, detected through a literature review, in integrating the concept of sustainability and resilience within architecture curricula.

Then, the characteristics of a critical learning praxis in architecture are retrieved from the literature, to identify the tools adopted for enabling students in a broader interaction with societal actors and dynamics (Par. 3). The critical learning model is then empirically analyzed through the study of five international pioneering samples of experiential and inquiry-based architecture learning. They share the common approach of in-field exploration, but they have been selected as they deploy a range of different tools, such as service learning, action-research, living labs, design-build, applying them in highly diverse geographical contexts (North America, South America, Europe, Africa, Carribean). These were analyzed through a series of interviews with the main actors of the educational process engaged in the learning experiences (Par.4). The study outcomes related to the interviews and to the direct observation of the cases are then exposed, in order to explore the implications of a context-based learning in equipping students with active knowledge and in the process of engagement and dialogue between diverse communities (academia-citizens-policymakers-practitioners) (Par. 5). A critical review of the outcomes allows to identify key lessons on methods, limitations and trajectories for further implementation (Par 6). Conclusions focus on the need for shifting the pedagogical paradigm towards an in-field-experience-based model which can improve the awareness of future practitioners for climate implications of architectural design. This implements their analysis and project skills, by triggering shared learning processes (co-production) at community and decision-making level, which push them addressing the large range of the involved societal and cultural issues. (Par. 7).

2. Integration of sustainability and resilience in architectural education

The integration of sustainability in higher education has increased worldwide over the last decades [9] and a major focus on the sustainability approach has been registered in architectural education too [40,42]. Despite this, several institutional and professional actors still call for an overhaul of the curriculum to make this integration stronger [40, 43]. Some scholars have highlighted the opportunity to introduce a more holistic conceiving of sustainability that goes beyond the specialistic expertise supporting architectural design to become the real core of tomorrow design activity [35, 44]. This basically requires a more pervasive understanding of sustainability and resilience feeds architecture programs [40, 44, 45]. Thanks to its multidisciplinary nature, the education in architecture, urban design and planning could contribute in bridging that gap between environmental, socio-cultural, political and economic dimensions of the design practices, promoting a holistic vision [40, 44].

2.1 Barriers and gaps

A useful roadmap for the integration of sustainable environmental design is provided by EDUCATE project, which addresses the different levels and stages of architect education and professional training [40, 42, 46]. The study examined 70 architecture curricula in 30 European and non-European countries, by a detailed analysis which explores their learning contents, teaching methods (e.g., specialist lectures, seminars, workshops), pedagogical tools and assessment criteria, also including the staff-to-student ratio for both theoretical and applied learning modules of each curriculum. As it is one of the wider studies on the global trends in the field, the overview drawn by EDUCATE can be considered the one of the most comprehensive and exhaustive source in literature at the moment [47], providing a base for further more specific complementary surveys.

Numerous quantitative, qualitative and comparative studies on the subject are also underway around the world, focusing in particular on the perspectives and limits of introducing sustainability in architectural education. Porras et al. review the situation in Asia [47], Ostwald et al. depicts the scenario of the Australasia area [48], Lee et al. examines Korea [49], Taleghani et al. compares Iran and Australia [50], while Wright analyzes the integration in USA [51]. Other studies focus on the curricula's criteria of accreditation by ARB (Architects Registration Board), RIBA (Royal Institute of British Architects) and NAAB (National Architectural Accreditation Board), the largest boards that recognizes architecture programs worldwide and assesses the compliance of the architectural educational system to professional standards of excellence [52,53]. Santini has developed a qualitative analysis on the top ten Architectural Schools ranked by the World University Rankings of the British firm Quacquarelli-Symonds (QS), one of the world's leading higher education analysts [11]. Some studies have surveyed the educational experience of sustainability and climate change from students' perspectives [54, 55].

What emerges from this growing amount of literature is that each school addresses the integration of sustainability in the curriculum in very different ways, which makes the interpretation of the findings very challenging [47, 56, 57]. Despite the limitations due to their broad diversity, the reviewed architecture curricula show a shared convergence on some main barriers to overpass, namely:

- Ambiguous and unclear definitions of sustainable architecture, lack of agreement on the meaning of sustainability that reflect the need for more specific and shared indications [11, 40, 44, 46,50, 57, 58].

- Separation between theoretical and design studio modules, which those addressing sustainability are often episodic and not suitably integrated within the whole learning program [11, 44, 59]. Furthermore, the split between theoretical and applied teachings

often prevents the latter from effectively exploring the implications of the core theories studied, thus making the abstraction - which is a pillar for transmissive pedagogy model - a barrier in addressing the applications in real-context [39, 56].

- Predominance of a performance-based approach to sustainability, which sometimes limits the rise of adequate theoretical and formal speculations. Building Technology courses are the core of sustainability teachings [11, 46, 47] with a focus on energy efficiency, thermal control, ventilation, and lighting [11], while contextual environmental conditions, as the local identities and social dynamics are often overlooked.

3. Critical pedagogy and experiential learning as tools to embed sustainability

The detected gaps suggest the urgency to implement pedagogic models capable to cope with the complexity of the socio-environmental scenario in a more holistic and critical manner, as to better prepare future professionals to deal with reality in their practice. Empirical, evidence-based and experiential-based approaches to learning, are thus advocated to stimulate students to question principles through the practice and foster their awareness on the multiple interdependencies that sustainability implies in designing and planning [39, 40, 60]. We adopted this key assumption in addressing the topic within this paper, as it emerges as an effective vision to inspire curriculum overhaul.

The recurrent adoption of a hypothetical setting detached from reality as design field suitable for education is identified as a strong limit of the architecture curricula [7], whose negative effects go far beyond the integration of sustainability, but certainly represent the main barrier to its implementation. In his extended work on architecture and urban planning pedagogy, Salama points out that the mainstream educational practice of developing design projects on hypothetical assumptions lead in neglecting the contextual variables [6, 39, 56, 63]. He also criticizes the conventional practice as it triggers ready-made interpretations about the built environment which are conceived as isolated from culture and society. Being based on show-tell schemes and fueled by separated pieces of information, this pedagogy is held responsible of pushing a mimetic which the student's ability is in reproducing what has been taught [6, 64]. The problem-based or project-based methods typically adopted in architecture curricula often does not challenge the way knowledge is vehiculated, although they have a natural potential to trigger dialogue with the case studied [57,65]. This mainly results in a replication of best practices, without including diversity, and leads to an attitude of theory without practice, in the form of abstract and formal exercises, which address only some of the project outcomes and remain separate from people's daily lives [66].

The intense debate which has developed on the paramount significance of introducing real life issues in architecture education has pointed to a "field-experience approach to education" as needed complement of the share of learning devoted to abstract contents [67]. The conceptual framework of this approach refers to critical pedagogy, that Freire defined as a learning process in which the learner can develop connections between their own experiences and the social contexts, thanks to education activities embodying interactions with the reality [37]. This has been translated to architecture pedagogy by means of the experiential learning, a theory elaborated by Kolb and applied to the design thinking [38, 55, 57, 68, 69]. For Kolb the experiential learning is "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" [38]. According to this theory, the learner must be directly in touch with the realities being studied, as this allows a learning by doing approach is adopted to brought knowledge into practice so reshaping the traditional passive student/teacher relationship. This triggers a shift towards what Salama defines as transformative pedagogy, shaped by interactional and relational process

focused on critical inquiry [6, 39]. The student's awareness regarding the socio-environmental responsibilities, that the act of design involves, can be developed by making them active agent in investigating what lies underneath the current development pattern of architectural production. To this end, the process must address the physical and spatial dimensions as well the cultural issues and rules, social justice, community aspiration and environmental dynamics. This leads in reconsidering the architects and planner's role in shaping the built environment, promoting a self-reflection on both how architectural knowledge is produced, and on the values, belief systems, exchanging dynamics between multiple systems (environmental, economic, social and political) that nurture the creation of the built environment [6].

Thus, critical learning is conceived as a continuous process rather than an outcome, and it is grounded in experience reflecting the human adaptation to the social and physical environment [38], so making the built environment become an open book for students [6].

3.1 Research-based learning and experiential active learning in architecture

Applying an experiential learning model to architecture and urban planning can be effective as it pushes to dial with their complexity and multidimensionality [63, 68]. Such model has been so recognized as a needful approach in educating for sustainability, which is an interdisciplinary domain requiring interconnected way of thinking and inquiry [40, 57]

In fact, sustainability cannot be pursued as an additional value to the design outcomes, but as a matter to be explored through an iterative process of action and contextual-responsive reflection [57].

Several attempts to make this model happens have been tried: action-research [69, 70], design-build [71], live projects [72], service learning [73], real world context [74], and inquiry-based learning [6, 56]. The variety of these experiences carried both in design studios and theoretical classes shows that a research-based teaching strategy is key to implement a critical learning model fostering analytical skills and critical thinking. The application of Kolb's experiential learning cycle including actual experience, reflective observation, abstract conceptualization, active experimentation is proved to be effective for students that can relate to the subject matter in a way that is meaningful to their own lives [38, 68]. According to this approach, the contextual variables which are considered by the analysis and then fuel the design responses are not prefixed or determined as acritical assumptions, but they are explored as a dynamic field. This is expected to better reach the purpose to learn how to dialogue and mediate between conflicting inputs, interests and values, coupling the two conceptions of the built environment, namely the conceptual/subjective and the physical/objective one [6]. A further merit of experiential learning practice for sustainability is the opportunity to leverage a process of engagement and social interaction within the learning community (teachers-students) and outside it, as in stakeholders' groups, local communities, decision-makers [60-62]. This can be motivational for the students, allowing them to experiment different types of engagement, recognizing behavioral, emotional, and cognitive ones [72]. Since the methodology adopted in teaching can affect these perceptions, some relevant variables are identified within the analyzed case studies.

4.Methodology

4.1. A case study approach

In order to explore the implications of the sustainability-driven, emerging needs in architecture education, a set of case studies have been selected and analyzed in depth.

The cases are architecture education programs applying at least some of the experiential design principles reviewed in the previous paragraphs, including design studios, intensive workshops, fieldworks, inquiry-based courses. The selected experiences developed different methods for critical learning such as: action-research; service learning; community outreach; design-build; living-lab.

They belong to different national educational frameworks and high diverse geographical contexts (Europe, North America, South America, Africa, Carribean).

They share the use of real contexts and a case study method to allow students to gather empirical information from the field to be confronted and articulated with more theoretical and technical notions, promoting both direct observation and engaged participant observation [75].

The programs have been selected according to a criterion of diversity in targets to which they are designed for [76] and easy contact with the teaching staff that manage them [77].

Each experience mainly addresses some specific subject within the sustainability, climate change and resilience general topics. The choice of the focus basically depends on 2 factors: specific topic and theory background of the teaching program and specific sociocultural context of the case proposed to the learners as application field. The specific focus addressed are community resilience, socio-ecological vulnerability, climate governance, landscape, disaster risk reduction and climate change adaptation, climate resilient-design, construction materials, buildings life-cycle.

All cases refer to program spanning over more than one semester, most of which are still currently on-going. Detailed pieces of information on the cases are provided in section 4.3.

According to the recognized definition of this methodology, the analysis of the case studies is configured as an empirical and interpretive framework that allows the researcher to inquiry a contemporary phenomenon within its real-life context [78-80].

Being an exploratory study [78], its main goal is to accomplish suggestions and insights from the cases, rather than reaching a deep understanding nor learning key lessons from each of them [81]. The analyses aim to gain a set of possible pathways to integrate sustainability and resilience in architecture education.

4.2 Research design

Since the study aimed at exploring the core elements of the educational experiences of some leading actors, the interview has been selected as suitable mean for this purpose, according to the reference methods for case study analysis [82]and also due to the difficulty to obtain data through more quantitatively oriented methods [83, 84].

Nevertheless, we integrated the face-to-face semi-structured interviews with data collection of background information on each program syllabus, as well as with the outcomes of in-field direct observations.

Data have been collected from multiple sources to complement the interview narrative description, so aiming at enhancing the study trustworthiness [84] and consistency [82]. Direct observations provided insights on social settings and on triggered interaction and participation, giving to the researcher additional knowledge on the case studied [82,85, 86]

With reference to the interviews set up, the respondents have been selected as individuals that are especially knowledgeable about each case and experienced with the topics addressed by this research [86]. Accordingly, they play the role of key informants, according to purposive sampling criteria [87].

Furthermore, the interviewing is recognized in the literature as a primary research method for investigating educational processes through the individual experience of the people who carried it out [83, 88, 89]. This leads to consider interviews a suitable method to: 1. identify unique aspects of the cases; 2. understand the socio-cultural context of the learning experience; 3. gain thick descriptions by eliciting deep reflections, especially in information-rich cases [83, 89]. Six in depth semi-structured interviews has been conducted in May-June 2021 with open-ended questions to reflect the respondents' own perceptions, facilitate detailed response on the study topics and program [90].

The interview has been designed to assure that the same questions are asked to all participants, and to foster the interaction of respondent and interviewer on a broad set of topics. The interview includes seven main questions (Appendix A), focusing on the role of experienced-based models of learning in vehiculating sustainability and resilience into architecture curricula. The questions are on: which tools for learning are adopted by the program, how contextual sustainability and skills enhanced by the learning experience are integrated; which are the applied methodologies and their enabling factors and limitations; how the evaluation is made of the student educational pathways; if and how the co-production of knowledge outside the educational domain is realized; if and which key expertise and responsibilities emerge for future architects and educators; which key architectural research and educational topics to be further developed in the curricula, if any.

The respondent profiles provided in Tab. 1 allow to identify the relevance of their role to this study context, their experiences in education and research field and their specific knowledge on sustainability and resilience in architecture.

Table 1. Profiles of respondents

Respondents	Case	Profile	Research Field
R1	1	Associate Professor in Urban Design, Director graduate program in urban & regional design at, New York Institute of Technology,	Climate-resilient design and planning, sustainable architecture
R2		Assistant Professor in Technological and Environmental Design PhD Research Fellow of PLINUS STUDY CENTER, Department of Architecture, University of Naples Federico II	Climate-resilient design, Disaster Risk Reduction, Sustainable architecture
R3	2	Assistant Professor in Architecture, Landscape and Infrastructures, Department of Architecture, University of Bologna	Community-based architecture
R4	3	Associate Professor in Urban Planning and Planning Theory, Person in charge of Public Engagement Unit, Department of Architecture, University of Naples Federico II	Community-based planning, Environmental Justice, Political Ecology
R5	4	Associate Professor in Technological and Environmental Design, Academic Sub-director of the Faculty of Architecture, Design and Urban Studies of Pontificia Universidad Catolica de Chile	Sustainable architecture, Disaster Risk Reduction, Construction materials, Community-based architecture

R6	5	Assistant Professor in Urban Planning and Territorial Governance and Management, Director of Cities Observatory UC and of Programme Plans and Urban Projects UC, Faculty of Architecture, Design and Urban Studies Faculty, Pontificia Universidad Catolica de Chile	Disaster Risk Reduction, Climate Change Adaptation, Territorial Governance and Planning

4.3. Description of the cases

Table 2a and 2b provide a synthetic description of the selected case studies. Being gathered from each program syllabus, booklets and publications, the provided pieces of information concern: the territorial context on which the learning experiences focuses, the program disciplinary fields and the active learning activities they include; the topics the program declared to address; the specific matters within which the program embedded contextual sustainability in learning activities and carried evidence-based projects; the expected outcomes as both explicit assignments and additional independent products got from experiential learning [91-100].

Table 2. a. The analysed case-studies: background information.

CASES	
C1	**UCCRN Edu-Urban Climate Change Research Network Educational**
	Within the global research network of UCCRN based at Earth Institute of Columbia University, an educational initiative has been established since 2015 with the aim to integrate and scale-up climate change mitigation and adaptation in cities through knowledge sharing, collaboration, and action planning. Several partner institutions (Polytechnic of Milan, New York Institute of Technology, Université Paris Est Marne La Vallée, Aalborg University) joint the network delivering studios within the Faculties of Architecture and Urban Climate Design Workshop (UCDW) Intensive Study Programmes implemented in several cities (New York 2017, Napoli 2018, Aalborg 2019, Paris 2020). We refer in particular to the experience of Urban and Landscape Regeneration Studio 2016-2019 (Polytechnic of Milan, Sustainable Architecture and Landscape Design Master Programme), and Urban Design Climate Lab 2015-2021 (New York Institute of Technology, Architecture, Urban & Regional Design Master Programme).
C2	**LED2LEAP-Landscape Education for Democracy towards Learning Empowerment Agency Partnership**
	LED2LEAP-Landscape Education for Democracy towards Learning Empowerment Agency Partnership: the study course has been developed in the framework of ERASMUS+ European Union grant program (2019-2022) with the aim to prepare the future generation of landscape architects, planners, architects, and designers for their role as democratic leaders for sustainability. The consortium consists of the following university and NGOs: LE:NOTRE Institute (Netherlands), Hochschule für Wirtschaft und Umwelt Nürtingen-Geislingen (Germany), University of Bologna (Italy), Hungarian University of Agriculture & Life Sciences, Swedish University of Agricultural Sciences and the NGO Partners KultúrAktív (Hungary) and EtaBeta Cooperative (Italy). Here we take in consideration the two modules course (theory on Participatory Action Research and the Living Lab) carried on by the University of Bologna (2020-2021), designed for master and doctoral students of Faculty of Architecture and Civil Engineering
C3	**Ponticelli SmartLab and LAC-Climate Action Lab Naples**
	In the framework of two participatory research projects of University of Naples Federico II (Metropolis project and Occupy Climate Change) educational activities have been developed at Department of Architecture from 2017-2021 (Intensive Workshop Programme, Living Lab and research-based courses) to foster public engagement on the topic of climate-resilience and promote service-learning initiatives for students. For this study we focus on the experiences of the course "Tools for Territorial Transformation 2020-2021" (Sustainable development and Territorial Network Bachelor Programme) and Resilient Cells Intensive Workshop Programme within the Living Lab Ponticelli SmartLab 2017 (Architecture Master Programme).
C4	**Design-build Reclaiming Heritage**
	A network of teachers and students have been established since 2009 at Faculty of Architecture of Techniche Universitat of Berlin (Habitat Unit chair) to engage Design-Build learning and research activities through studios and intensive workshop programmes for faculty students at master level. We explore the experiences of two major post-disaster reconstruction educational activities, Chanco Prototype (2010-2013) and Rebuild Haiti Homes (2013-2015).

C5 **PPUC-Plans and Urban Projects Programme Universidad Católica**

The programme belongs to the Faculty of Architecture, Design and Urban Studies of Pontificia Universidad Católica de Chile. It has the mission to provide a framework to create convergence between applied research of urban and territorial development, planning and management, governance structures and educational activities. In this study we consider two research-based courses, Resilient by Design: urban project Diego de Almagro (Master Laboratory of Research and Design 2017-2019) and Multi-Hazard Santiago: Underlying Factors for Resilience Assessment, Integrated Planning and Design (Laboratory of Research and Design 2020). Both are curricular courses of MPUR-Master in Urban Design and MASE-Master in Sustainable Architecture and Energy.

Table2b. The analyzed case-studies: detailed information

CASES	Context of case studies	Disciplinary field	Topics	Variables examined	Student Outcomes
C1	New York, Gowanus (USA) East Naples (Italy)	Building Technology Urban Design	Climate Resilient Design	Urban climate hazards (Heat waves and Flood) Urbanization trends Infrastructures Urban Form Technologies and Materials Vegetation cover On-going planning Community Needs	Climate Analysis Scenario-Based design Projects Videos Collective mapping
C2	Bologna, Community of Ex Villa Salus (Italy)	Urban Design Landscape	Landscape and democracy Action Research	Social innovation Socio-cultural integration Local food production Waste Local Networks Mobility	Participatory Analysis and synthesis Collaborative visioning Co-design and Transformation
C3	Naples, Ponticelli and Historical centre (Italy)	Environmental Design, Urban Planning	Climate Resilience Community Resilience Community-based adaptation	Socio-ecological Vulnerability Community Resilience Bottom-up Initiatives Governance On-going planning	Urban Analysis Participatory Surveys Co-design Self-construction
C4	Chanco (Chile) Croix-des-bouquets (Haiti)	Environmental Design and Building Technology	Heritage Building Life Cycle Local Materials Low-tech Post disaster interventions Community Resilience	Climate related and geophysical Hazards Bottom-up Initiatives Social Vulnerability Construction Materials and Technologies	Co-design Self-construction
C5	Diego de Almagro, Chanaral, Region Metropolitana Santiago, Litoral Central (Chile)	Urban Planning Urban Design, Environmental Design	Disaster Risk Reduction Climate Change Adaptation	Climate related and geophysical Hazards Governance On-going planning Vegetation Patterns	Urban Analysis Interviews Environmental surveys

Services and resources	First-hand Research
Infrastructures	Videos
Bottom-up Initiatives	
Social Vulnerability	

5. Outcomes

The study outcomes are divided into two subsections (5.1, 5.2): the first reports the main results collected from interviews, the second one summarizes specific information retrieved by both the interviews and direct observations.

The answers to the seven main questions are provided in form of thematic analysis, to better identify commonly recognized patterns and relationships which meaningfully answer the research questions of this study [101]. Tables 3 to 9 provide the thematic analyses of the respondents' answers to each question, by quoted excerpts from their interviews.

Then, further complementary information on the external actors engaged in each case, the typology of activities developed and their outcomes beyond the educational domain are also reported.

5.1 Thematic analysis of interviews

5.1.1 Effectiveness of experiential model of learning

Question 1 is about the effectiveness of the experiential learning model to integrating sustainability, climate change and resilience within the architectural curriculum.

The majority of respondents argues that the student engagement in real-life context represents the main potential of experiential learning model. They stress on the effects of this in-field interaction with complexity as a mean to foster the inclusion of diverse input within the design and planning process.

"*Working with a real context creates a transformative experience through which students perceive the complexity of what it means to interact with the problems of climate change at ground level. This allows them to deal with multidisciplinarity, and specialistic components while they learn to interact with the territorial actors of physical transformations, such as decision-maker and people having in that context their daily dimension.*" (R2)

What emerges as a largely shared opinion is that the experiential learning process allows students to understand the urban planning and architecture projects beyond the purely aesthetic or formal dimensions, discovering how the process-based dimension affects architecture.

Within this framework, most respondents consider the experiential learning a way to suitably ground major environmental challenges, such as climate change, and to supply student the evidence that sustainability is a mediated outcome, needing their knowledge is integrated with multiple interests and perspectives.

"*Students are called to reflect on the role of actors engaged in the process of transformation of the built environment, for example translating UN-Sustainable Development Goals in specific contexts where constrains of territorial planning, spatial governance and political issues make hard to introduce effective changes. This pushes them to learn to give due weight to the vulnerability and fragility of territories and people*" (R4)

High attention is given by respondents to the social dimension of the learning activities, due to its potential of triggering experiences able to radically influence the student choices on their future career.

"*The design-build projects we developed overcome the purely technical or academic dimension, as they were community-related and faced real process, real material, institutional barriers, lack of technical skills and available economic resource, as well as of people engagement and willingness. This strong contact whit the actual operational conditions change architectural education, often acting as a life-changing experience for students and their perspectives on their career and professional future.*" (R5)

Table 3. Thematic Analysis question 1

Thematic Analysis question 1	**Respondents**
Transformative approach	R2
Real-life context stimulates to work with complexity	R1, R2, R3, R4, R5, R6
Sustainability as mediated outcome among multiple interests	R4, R3
Sustainability as an empty label	R3
Context-based feasibility of climate resilient measures	R4
Inclusion of multiples inputs and perspectives	R1, R2
Climate change issues visibility and work on it at ground	R5, R2, R4
Life changing experience, orient further career	R5, R2
Reflect on the role of actors engaged in the process of transformation	R2, R4
of the built environment	R2, R4, R5
Understanding of constrains of territorial planning, spatial governance and political issues	R1, R2, R4
Understanding of urban design, architecture projects and planning as processual, overcoming aesthetic and forms	R3, R4, R5
Human dimension of architecture and community needs and conflicts, daily life	R3, R4
Overcoming of the sustainability as purely technical	R3, R4, R5, R6
Inclusion of identity of people and places	R5
Experiencing materiality of doing and building	R6
Understanding of interlinkages between urbanization processes with environmental processes	

5.1.2 Tools for learning contextual sustainability and students' skills

Question 2 explores the use of suitable tools for integrating contextual sustainability with students' competences enhanced by the learning experience itself.

High variability is recorded of answers on which tools can be the more suitable in embedding contextual sustainability and resilience goals within design, while wider consensus is encountered on skills that such tools can enhance in students.

Two main tool typologies are identified by the respondents: those for assessment and the process-based ones. The tools for environmental performances assessment of built environment are included within the first typology, as well as those for climate analysis.

"*The students have to learn applying tools to assess the built environment environmental performances and measure the response of architecture to stressing climate conditions. They can so go beyond the mere form in designing architectures and consider environmental parameters as means to give quality to the projects beyond the solely technical dimension. Tools for process*

analysis and assessment are as well necessary to understand the social and political context of the interventions." (R2)

Those included among the latter by most of respondents are tools to work on the field, engaging interaction with social and political spheres of the studied context, such as participant observation, field work, focus groups, interviews, roundtables. They mainly belong to social science and ethnography, and allow to collect thick data, and information that help to contextualize the project as a process that must dial with multiple actors.

"*The students require methodological preparation to be capable to integrate information not just on needs, expectation and claims of communities (that could be relatively simple) but also on decisional and governance constrains and power relationship. They need tools for active learning and observation, to represent what they found, and to communicate the findings to the engaged actors….*" (R4)

Tools for the graphic representation of information are thus considered also important for both the architecture outcome and to feed the dialogue with communities and public actors restituting the analysis the data collected on the field.

Intensive workshop programme (IWP) is a learning tool cited by most respondents as able to immerge students within local context in a direct and focused way.

"*IWP is an important moment in the educational development, as it is an intense learning experience where be together, live together, inhabiting the intervention place, so creating a physical and emotional approach to the course subject. Students are immerged in the reality of the project, and they feel the experience*" (R3)

The most mentioned skills that these tools improve in students, are the ability to communicate with different actors, the ability to create dialogue, to mediate conflicting inputs and interests, and to generate active and proactive commitment.

Table 4. Thematic Analysis question 2

Thematic Analysis question 2	**Respondents**
Tools	
Learning tools are tailored to gain specific outcomes	R1, R6
Traditional learning tools such seminars	R5,
Applied Research Methodologies	R4, R5, R6
Performance-based and scenario-based tools	R1, R2
Process-based tools	R1, R2, R3, R4, R5, R6
Round tables with political actors and relevant authorities	R4, R6
Focus groups with local communities, NGOs	R1, R2, R3, R4, R5, R6
Intensive Workshop Programmes	R1, R2, R3, R4
Participant Observation	R4
Field work	R4, R5
Mapping of actors	R6
Interviews	R4, R5, R6
Videos and visual communication	R2, R6
Diagramming and graphical representation of information	R1, R4
Reading, writing exercises and discussions	R5, R6
Creative discussion and brainstorming	R6
Active listening and interaction with public actors	R4
Representation of field information to feed the dialogue with communities and public actors	R4, R6

Reading and deconstruction of decisional documents	R4
Capacity building with local actors	R2
Co-design	R2, R5
Gamification	R2
Living Lab	R3, R4
Skills	
Capability to communicate with different actors	R1, R2, R3, R4, R6
Capability to understand climate change at urban level	R1
Ability to create dialogue and mediate between inputs and conflicting interest	R2, R4, R5, R6
Ownership of the design process	
Horizontal partnerships with actors	R2
Creativity	R2, R4
Active engagement and proactiveness	R3, R4
Professional attitude	R3, R4, R5, R1, R4

5.1.3 Methodologies, enabling factors and limitations

Question 3 was aimed to identify the methodologies adopted for experiential learning and which have been the enabling factors and limitations encountered.

Several answers focus on enouncing principles which inspired the methods selection, rather than specify in detail how these latter are built. The more frequently mentioned principles concern: creating synergies between research and education and with public actors and local communities, facilitating students in the interaction with real contexts and deliver to them practical tools to do it, by integrating the knowledge gained from the field within articulated outcomes. According to what explicitly argued by some respondent, the applied methodologies are intended as ways:

"*To adjust theoretical knowledge to real problems*" (R5)

"*To create hybrid environments that can allow sharing, collaboration and participation of diverse actors (experts, decision makers, city officials, students). This provides a suitable framework to build Research-Action pathways bringing together experiential learning, public engagement, and applied research*" (R4)

"*To dialogue with the case complexity by operating in-field* " (R2)

An applied research model is frequently declared to be the reference on which the methodologies are set, to create an exchange between research trajectories and the operating field. Since field work is the preferential way for experiential learning, the application cases in which bigger networks and partnerships between territorial agencies and communities are involved, represent more often effective opportunities for enabling the student engagement capacity.

"*Students are embedded in a context of applied research; we teach what we research. What they study matters to the sustainable transformation of the built environment and to people who live that environment. An inquiry-based method means to think out of the box, where are no given question or predetermined answers. So, students vehiculate in interactive ways the knowledge they have gained in field. This both for design studios and more research-oriented courses too.*" (R5)

In addition to the duration of the action and availability of economic resources, two enabling factors are identified as more relevant, namely building of a long-term

partnership with public actors and communities, and the capability to clearly socialize and communicate what this partnership can do.

The claimed major limits concern the divergences and conflicts between research or educational goals and community expectations, and the mismatching between short-term academic timing (duration of courses and workshops) and long-term territorial processes (at political and community levels). An unclear definition of research results and a lack of scientific rigor are also cited as causes of failure.

"*The experiential activities such as Living Labs can generate expectations in communities. This may easily trigger divergencies and mismatching between the research goals and community aspirations*" (R3)

Table 5. Thematic Analysis question 3

Thematic Analysis question 3	Respondents
Methodologies adopted	
Inquiry-based projects	R4, R5, R6
Research-based cases	R1, R2, R4, R6
Field works	R1, R2, R3, R4, R5, R6
Bottom-up survey	R3
Training to focus groups	R6
Design of Action-Research projects	R4
Living Lab	R3, R4
Service Learning	R4, R5
Creative Brainstorming	R6
Collective Mapping	R1, R2
Enabling Factors	
Active networking between university, local communities, public actors and civil society agencies	R1, R2, R3, R4, R5, R6
Sufficient time to build the context-based experience	R2, R4, R5
Long term engagement of researchers/educators on the field	R4, R5, R6
Financial coverage for at least 3 years	R2, R4, R5, R6
Think out of the box	R5
Clarity to not rise expectations in communities	R2, R5,
Ability to manage divergencies and conflicts	R3, R4
Clarity and flexibility of the approach and adaptability of the methodology to the context	R2
Engagement of key actors during a previous time window	R2, R4
Previous knowledge of the key actors on the topics	R2, R4
Limitations	
Lack of scientific rigor (complexity of different disciplines) in favor of educational results	R2, R6
Limit of research outcomes and divergence between research goals and community expectations	R2, R3, R4
Risk of create expectation in communities	R3
Risk of manipulation by political authorities	R4
Lack of economic resources	R4
Urban Policies constrains	R2
Mismatching between academic timing (e.g. semester courses) and local processes	R2, R4, R5, R6
Distrust in public institutions	R4
Pandemic and social upsurge as barrier for fieldworks	R4, R6

5.1.4 Evaluation of the students' educational pathway

Question 4 concerns the assessment of the students' education pathway and how the outcomes are evaluated. A comprehensive evaluation of the progresses the students reached during the whole learning experience is mostly adopted rather than assessing just the results achieved at end. The student active engagement in Intensive Workshop Programmes often highly increases the score.

"*Assessment focuses more on learning than performance. What matters is that students are able to approach field work methodically. This requires them to be involved in cross-cutting interactions even beyond the specific educational aims of the program, as the main target is precisely to support students in this experience, from which they may learn something relevant for their life*" (R5)

Personal skills such as the proactiveness, engagement in the field and capability to be creative and flexible are considered as valuable skills in experiential learning.

"I evaluate the capability to be active and not a passive recipient. The experiential learning in itself looks to shift the student attitude, so their willingness to be active protagonist is crucial, even when this means to fail or face troubles. It's not important the result but the engagement on the field, as the outcome can also be limited, but the student will cope with the complexity of the context and this is more relevant" (R4)

Story-telling and representation skills are also considered in the assessment process of most programs, as is for the capability of managing complex information (e.g. quantitative and qualitative analysis).

"*The student's only skill that I consider really fundamental is to be able to represent complex reality in its multiple layers… Graphic representation has to translate conceptual clarity […]. The verbal capability is also important, as is that of creating compelling narrative. The communication by multiple tools is fostered and students which learned to discuss with stakeholders are well scored, as this is a very useful skill for their career*"." *(R1)*

About the assessment modes, most programs adopt a three steps scheme: a first checking stage on the initial context analysis and literature review, a second one on the preliminary proposal while the third one is on the final design stage or inquiry-based project. A specific assessment session and extra score is often devoted to intensive workshop program, as they are not always embedded within the main classes. A formal final exam is provided for all programs.

Table 6. Thematic Analysis question 4

Thematic Analysis question 4	**Respondents**
Modes of evaluation	
Comprehensive evaluation of the students progresses	R1, R2, R3, R4, R5, R6
Intermediate evaluations	R1, R2, R3, R4, R5, R6
Final exam	R1, R2, R3, R4, R5, R6
External jury for final evaluation	R5, R6
External jury for reviews and comments	R4
What is evaluated	
Focus on learning processes of students and not on their performances	R2, R3, R4, R5, R6
Student engagement with the case in the field	R3, R4
Capability to investigate the field and the broader context	R3, R4, R6
Proactiveness	R3, R4, R5
Design skills	R1, R2
Narrative and story-telling skills	R1, R2, R6

Ability to integrate in the project theory and analytical contents	R2, R4
Ability to work in team	R1, R2, R5
Communicational skills	R1, R6
Capability to convey the work done to community and public actors	R1

5.1.5 Co-production of knowledge and impacted domains

Question 5 is about the experiences of the interviewed in knowledge co-production among diverse actors (mainly public authorities and communities) and particularly investigates which are considered suitable practices for this scope. Despite the variety of the analyzed programs, some common trends emerged for co-production pathways, namely:

- the engagement of students in public debate on built environment transformation
- the integration of data from field work in the design stage as a mean to leverage community action and bridge it with decision makers based on shared evidences
- the creation of hybrid interfaces that can reflect changes in real practices.

"Students learn more in the outside and real world then in academia, as they better learn to be young professionals by participating to the public debate" (R6)

"Students have become the key, the bridge with local communities, and this is precisely a model of experiential learning that builds knowledge through co-production. Outcomes are built together with local actors and everyone engaged is co-learning something" (R4)

"All actors are influenced by how they are involved in the process and how they bring knowledge into their reality. In my experience, student studies and projects provide the community with the means to push policy makers to action, so becoming a policy statement. This desirable effect shows how effective we are in conveying the work to the community and clarity about the projects. For example, in Gowanus the city officials started to take in consideration climate projections in planning being pushed to this by the community we worked with, while in Naples the climate analysis we carried has suitably integrated the community knowledge and its real needs" (R1)

"I often encountered issues about power symmetries. Decision makers often don't know so much about people and territories and inversely community don't know about the complexity of decision-making regarding spaces. The fieldworks studies require a long-term relationship with inhabitants but allow to overcome this gap, making visible things that are often neglected by both research and public authorities. Working with communities and public actors is a complex partnership, exposed to the risk of manipulation of the findings for political purpose. Building hybrid interfaces which stimulate participation of a plurality of subjects may overcame this risk." (R4)

5.1.6 Key expertise and responsibilities of future architects and educators

The ability to think critically and to figure out and visualize desirable transformations are indicated by most of the respondents as the key competences for future architects. Expertise in graphical and visual representation helps in bridging multiple interests and mediate between conflicting visions.

"Students have become expert in being part of complex processes, avoiding being reductivist. This is the needed expertise to accept conflicts, dialoguing with different perspective. Critical thinking is fundamental to orient processes to future trajectories and transformative pathways" (R4)

A recurrent claim in interviews is on the architect social role, which is considered as a key awareness students must be provided of. This push them in conceiving the profession as a way to be civic engaged and their role as that of active citizens.

"They have to think, behave and design as citizens. They have to know that their profession is about what the people or the city really need" (R6)

Great emphasis is also given by respondents to the role that architect can have inside local communities.

"Future architect must be trained to facilitate communities in developing new imaginaries and identifying their aspirations, not just their needs. They can bring awareness and empowerment translating their vision of the future" (R4)

The implementation of critical learning and the strong integration within the architects' curricula of context-based practices are widely shared by the respondents as crucial means to build dialogue with the local context and to convey, co-produce and communicate knowledge between students and communities. Many educators say they feel it is their responsibility to inspire students to reshape solutions based on specific circumstances and contextual variables. But also making them able to bridge technical knowledge, natural sciences and social sciences in a multidisciplinary perspective.

Table 8. Thematic Analysis question 6

Thematic Analysis question 6	Respondents
Key expertise for future architects	
Critical thinking	R1, R2, R4
Dialogue with other disciplines	R1, R2,
Visualization of desirable transformation	R1, R2, R4, R6
Management of complex processes	R1, R2
Graphical and visual representation to bridge multiple interest	R1, R2, R6
Coping with uncertainty and flexibility	R4, R5
Listening and observing	R4
Key responsibilities for future architects	
Civic Engagement and social role	R2, R4, R6
Role of facilitator	R2, R4
Support communities in building local and international networks	R4
Support fund raising for community-based local transformation	R4
Contribute to increase awareness on climate change	R1
Key responsibilities for educators	
Build the dialogue with local context	R2, R4, R3, R6
Vehiculate, co-produce and communicate knowledge with students and communities	R4, R3
Bridge technical knowledge, natural sciences and social sciences	R1, R2, R6
Stimulate the understanding of broader implications of architecture practice on environment and society	R1
Stimulate to reshape solutions basing on specific circumstances and contextual variables	R3, R4

5.1. 7 Key architectural research and educational topics

Question 7 asked respondents to indicate three main challenges and topics to be further developed in the curricula to better meet societal needs and address uncertainty. They have reacted to this request by providing a rich set of answers. Although several of them

are not convergent, shared opinions emerge regarding the implementation of co-design, community-based architecture and planning, as well on integrating climate-related evidence within a more science-based architecture.

"We need methods and practical tools for co-design and for evidence-based projects to deliver quantitative and scientific analysis to be mediated with field information. This integration has to be pursued to interact with collective intelligence and the complexity of reality. For example, an effective tool to be further investigated is gamification" (R2)

Different nuances emerge among the answers also regarding the topic of uncertainty and risk.

"*We need to better manage the societal challenges we are facing and confront with the complexity. Design thinking is a way to do that: as architect we are problem solvers and cross-sectorial thinkers with unique skills."* (R1)

"The topic of the integrated risk (social and environmental) is embedded in current society and represents the frontier of uncertainty. We need to cope with fuzzy answers through preparedness, approximation, and intuition, so staying in uncertainty without succumbing" (R4)

Further recorded suggestions are about fostering of multiscale synergies between architecture and planning, which is perceived as a way to deal with the current challenges, and policy coordination, that could be a mean to address still emerging topics such as resilience, disaster reduction and climate change adaptation by shifting the way sustainability is traditionally vehiculated into the curricula.

"We need to move forward bioclimatic architecture, energy efficiency and sustainable development. We need reconceptualizing the building life cycle, health, comfort condition and circular economy, by embedding more meaningful frameworks such as resilience, disaster risk reduction and climate change adaptation. The idea of sustainable architecture is obsolete. The need and demands are strongly changing, and they call for processes deeply embedding the uncertainty." (R5)

Table 9. Thematic Analysis question 7

Thematic Analysis question 7	**Respondents**
Co-design, Community-based architecture and planning	R2, R4, R3
Science-based architecture, climate-evidence	R2, R6
Gamification	R2
Policy coordination, synergies between architecture and planning, multiscalarity, Nature-based solution and socio-ecological dynamics	R2, R6
Interlinkages with larger societal challenges	R2
Cross-sectorial thinking	R1
Disruptive Technologies	R1
Self-sufficiency and energy grids	R1
Public realm	R1
Rebalancing of humanities and science teachings in the curricula	R1
Creativity, dimension of doing and manual skills	R3
Reading the spaces and territories through the lens of people	R3
Socio-environmental risks and preparedness	R3
Community-based Research and Action-Research	R4
Reconceptualization of sustainability in architecture	R4
Disaster Risk Reduction and resilience	R5
Technological and digital Innovation	R5
Role of governance, public authorities and power structures	R6

	R6

5.2 Learning activities, actors, co-produced outcomes

The information collected through direct observation of the programs during their development is summarized in Table 3.

The multiple data collected are organized aiming at relating them with what emerges from the interviews, so to highlight the extend of each experience beyond the purely educational domain. The external actors engaged in the learning activities are thus identified, as well the student profiles and the typology of the carried activities. The program's co-produced outcomes are also reported as well, as intended as the outputs that have been developed with actors during the experiential activities.

CASE	Typologies of activities	Students engaged	Actors	Co-produced outcomes
C1	Field work Collective mapping Co-design Focus-groups Round-tables Interviews	Master students	Local Authorities Practitioners Local NGOs Social Garden users Local communities	On-line collective map
C2	Living Lab Action-Research	Master and PhD students	Local NGOs Local communities	
C3	Field work and survey Living Lab Action-Research Service learning Focus-groups Co-design and Self-construction	Bachelor and Master students	Local Authorities Practitioners Local NgOs Social Garden users Local communities	Documentary Self-constructed prototype
C4	Field work Co-design and Self-construction	Master students	Local and International NGOs	Self-constructed prototypes
C5	Field work Focus-groups Round-tables Interviews	Bachelor and Master students	Local Authorities Local communities	

6. Discussion of results

Both scholars and educators attribute high effectiveness levels to the experiential learning models integrating the emerging sustainability-related issues within architect education programs.

The adoption of these methods mainly consists in addressing the teaching activities to real cases of design in actual contexts, assumed in their whole complexity and closely following their development. This leads in encouraging students to be an active part of the decision-making process which steers the project, and to work in the field by

establishing close relationships with site conditions and stakeholders to exchange knowledge and co-produce solutions.

This involvement is expected to make students more aware of the multiple dynamics fueling the design process, and train them to take into account much more variables than those usually considered in current architecture teaching programs. This is especially true for those variables that affect sustainability, in its various meanings and implications.

The potential of active learning in giving visibility to sustainability and climate change related topics is indeed recognized, as it is for all the topics affecting daily life of communities and so become matter of widely involving decision-making processes. This is deeply interlinked to the nature of the tools applied to deliver experiential learning activities because they are intentionally developed to embrace holistic perspective and architecture within a contextual key. This is especially pursued in design studios (CASE 1, CASE 4, CASE 5), through the combination of tools for assessment and process support which help to build trajectories on evidence-based information. Special attention is given by the programs to assure that co-design project be fueled by rich flow of both quantitative (such as climate analysis, study of environmental performances) and qualitative data (e.g. survey of community perceptions, needs, mapping of actors and local networks). The mix of tools provided (Tab. 4) and variables addressed by the programs (Tab. 2) shape a wide multidisciplinary education scheme, which is intended as a mean to cope with emerging socio-ecological challenges. Multidisciplinary often leads in long-term results for both students and stakeholders (CASE 1, CASE 4, CASE 5), in terms of technical evidence provided and socio-political variables surveyed.

Compared to the current training programs for architects, the accredited benefits to this scheme are the enhancement of some student skills, such as those of reliably mapping the multiple and diverse conditions the design must face and those of mediation and dialogue with multiple stakeholders, as well those of identifications and representation of the real needs the project must meet.

While the arguments supporting the adoption of experiential learning methods in architecture are richly reported in the literature, as well as the benefits that should derive from them, there are quite limited pieces of information regarding the implementation of study programs consistent with these premises.

Despite the analysis we carried on some of the worldwide most recognized programs inspired to those principles, many operative details and evidence-based achievements are still lacking. Even if the interviewed were all directly involved in managing specific programs, their answers were mainly focused on the theoretical background and conceptual assumptions while less emphasis was given to the concrete practical issues.

All of them expressed positive opinions on the effectiveness of the experiential learning model they applied and argue that the motivations that convinced them to adopt this approach have been confirmed in practice. However, no performance assessments based on pre-defined indicators nor student opinion surveys were used to support their position. This can be at least in part attributed to the novelty of most of the programs which, being very recently launched, do not have often enough elements to carry out a structured assessment. That said, some key aspects remain to be explored possibly according to shared indicators to evaluate the level of satisfaction, the level of gained skills against the real market requirements, the possible impacts on the working opportunities and conditions through further studies, since a more detailed knowledge of these pioneering experiences may facilitate the diffusion of the model and its wider adoption.

Among them, three main topics emerge with relevance. The first one concerns the specific teaching tools needed to support this learning model: having been mostly developed for social science purpose, a crucial issue deals with how they can be adapted to be implemented in architect education. The second deals with the availability of prepared and skilled teachers within architecture programs, to cover the wide range of disciplines that concur in providing the large set of knowledge these learning practices need to students. How they can be selected and appointed is an additional related issue. The third deals with the need to clarify to which extend the architect education programs can adopt this learning model and which is the share it must have within the whole package of knowledge future architect must be supplied of.

7.Conclusion

The proposed study investigated some pioneering experiences attempting to bring sustainability and resilience into architectural curricula through critical and experiential learning, assuming both as context-related elements. This is connected to the capability of universities to generate interactions beyond the academia and civil society, linking research, teaching, and community service.

The effects of the pandemic crisis and the ever-increasing evidence of the impacts of climate change clearly point out the need to evolve the response capacity of both the built environment and the related communities which is strictly connected to the need of a new generation of architects able to look at cities' development according to a wider, visionary, and cross-disciplinary oriented perspective. However, quite limited experiences of innovative educational programs in the field of architecture are currently working in this direction and most of them are still considered pioneering opportunities instead of frontrunners, reflecting the self-referential approach of traditional models. Despite the barriers and limitations emerged during this study the investigated experiences clearly pointed out some fundamentals principles that can be assumed as cornerstones for future educational programs of architects. In order to effectively embed sustainability at the core of architectural studies a more place-based perspective is need and the relation between human actions and local ecosystem must move to the heart of conceptual reflection. This is expected to be translated not into theoretical definitions but rather into a constructive co-creation dialogue with the key stakeholders with whom students must become trained to actively relate with, so enhancing the life quality of local communities and their environmental friendliness. The adoption of a critical learning methodology is a crucial element to build this dialogue capacity and to develop a genuine sense of civic responsibility. This has to be adequately supported by a cross-fertilization approach between different disciplines preventing the silos-thinking which does not match a resilient professional dimension. Last but not least, the main trends in social evolution, and especially the constraints due to the pandemic situation, required the introduction of new teaching tools and the use of innovative digital instruments to support the educational process: this is a powerful lesson learned on how difficulties may facilitate the adoption of new solutions. These tools are expected to be permanently integrated in the programs to facilitate the dialogue, to reduce distances, to encourage inclusion and to possibly support the model shift to make a change happens.

Appendix A. Interview guide

Questions:

1. How an experience-based oriented model can change the integration of climate-change/sustainability topics in architectural education according to your experience?

2.Which are the most effective tools for learning that have been implemented in your teaching experience, which skills they are capable to enhance in students?

3. Can you indicate synthetically methodologies/enabling factors/limitations?

4.Can you describe how did you assess the educational pathway of the students and how do you evaluate the results obtained?

5. Evaluate the effectiveness of the knowledge-transfer (academia-community-practitioners-decision-makers). Which are the impacts and on which domain (e.g. education, society, policy, research)?

6. Can you define which are the key-expertise and responsibilities for future generation of architects? Which are as well your responsibilities as educators?

7. Which are the lines of research/topics (3 main challenges) that need to be further implemented to meet societal needs and allow students of architecture to cope in their professional practice with a tangible crisis scenario?

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