Education for Sustainable Environmental Design
The EDUCATE Project
Summary of Results

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External Views of Ningbo Campus with CSET Pictured
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Foreword

I never teach my pupils;
I only attempt to provide the conditions in which they can learn
Albert Einstein

We live challenging times.

Awareness of the role that buildings play in the current climate crisis is bringing to the fore new responsibilities for architectural educators and practitioners. However, several pedagogical barriers still hinder the comprehensive implementation of principles and values of environmental sustainability in design studio, at all levels of architectural education. Concurrently, the promotion of practices of sustainable design in the professions of the built environment is not yet consistently supported by regulatory frameworks, whose validation and qualification criteria are frequently inhomogeneous and ambiguous, especially in ascertaining an effective integration between technical and imaginative skills. A substantial reconsideration of policies and pedagogical methods is needed to facilitate the transfer of knowledge between sciences of sustainability and building applications and foster the implementation of environmental sustainability within creative design.

To tackle such barriers, the EDUCATE (Environmental Design in University Curricula and Architectural Training in Europe) project has been funded by the European Commission’s Executive Agency for Competitiveness and Innovation (EACI), under the Intelligent Energy Europe Programme. Built on a consortium of seven European academic partners, and with the support of several regulatory bodies and professionals of the built environment, EDUCATE aimed to promote the effective integration of sustainable environmental design and energy efficiency in the education and practice of architecture and urban design.

This summary of results synthesises the outcomes obtained by the EDUCATE project from 2009 to 2012, so as to facilitate the transfer of its proposed principles, methodologies and tools to students, educators, practitioners, academic and professional institutions, and the general public at a global level, specifically encompassing the outputs featured in the following publications:

- State of the Art of Environmental Sustainability in Academic Curricula and Conditions for Registration (2010)
- State of the Art of Environmental Sustainability in Professional Practice (2010)
- Framework for Curriculum Development (2011)
- Results of Course and Curriculum Development (2012)
- EDUCATE Prize Catalogue (2012)
- Sustainable Architectural Education (2012)
- Criteria for Professional Qualification (2012)

The full versions of these publications are freely available for download from the EDUCATE website on http://www.educate-sustainability.eu/download
The EDUCATE Project

AIMS AND STRUCTURE

The role of higher education as a means of introducing new generations of architects and other professionals of the built environment to the principles and practices of sustainable environmental design is highly significant. The scale of the threat to the life systems of the Earth, the evidence of climate change, international regulations concerning the pursuit of sustainable development, and stringent market requirements, have all contributed to the understanding that students, educators and building practitioners are all charged with a significant responsibility in engaging with the sustainability agenda, although this faces a number of pedagogical and legislative barriers. The need to trigger a change in pre- and post-professional education that promotes a sustainable approach to design is mainly triggered by three factors:

1. Current building practice has been relatively slow to respond to the demands of fostering environmental sustainability within a creative design discourse;
2. Accreditation and qualification criteria do not consistently contribute to promote knowledge, skills and competence of sustainable environmental design amongst students, graduates and professionals;
3. Universities have been sparsely effective in integrating sustainability in higher education programmes.

To support the implementation of sustainable environmental design in academic curricula and professional training, the 3-year EDUCATE project was funded in 2009 by the European Commission’s Executive Agency for Competitiveness and Innovation (EACI) under the Intelligent Energy Europe programme. EDUCATE has been built on a consortium of seven academic partners: University of Nottingham (UK, Coordinator); Architectural Association School of Architecture (UK); Catholic University of Louvain (Belgium); Technical University of Munich (Germany); Department DATA, University of Rome La Sapienza (Italy); Seminar of Architecture and Environment, SAMA S.C. (Spain); and, Budapest University of Technology and Economics (Hungary). EDUCATE has also received the support of the Chambers of Architects in all participating European countries, of internationally renowned architects, of experts of cognate disciplines, and of associations of educators and practitioners. The mission of EDUCATE was to “foster knowledge and skills in sustainable environmental design, aiming to achieve comfort, delight, well-being and energy efficiency in new and existing buildings”. This was to “be promoted and demonstrated within a culturally, economically and socially viable design process, at all stages of architectural education” (EDUCATE, 2009).
EDUCATE was set to achieve the following objectives:

- Remove pedagogical barriers to the integration of environmental sustainability within creative design;
- Develop an online Portal that facilitates such integration in higher and post-professional education;
- Define a framework for sustainable architectural education reconciling technical knowledge and design;
- Propose conditions for accreditation of curricula and criteria for qualification measuring the knowledge, skills and competence of sustainable environmental design expected of graduates and practitioners;
- Disseminate know-how and exempla of best practice to students, educators, professionals and the public.

STATE OF THE ART

To identify existing hindrances and opportunities in integrating environmental sustainability in the education and training of building practitioners, the EDUCATE project has initially analysed and consolidated the international state-of-the-art of curricular structures and professional requirements at a European and at global level. To this aim, partners have conducted an exhaustive analysis of the state of play of education within architectural-related degrees, and have investigated how these relate to the conditions for accreditation of academic curricula and requirements for professional qualification as established by competent bodies. This task has also included an overview of education literature and a comparison of the state of the art with contemporary theories and practices. A total of 70 curricula have been scrutinised from some 30 European and non-European countries. These activities have been supported by cooperation with national regulatory bodies and have been accomplished via analysis of curricular structures, review of published documents, interviews and feedback obtained from academics. Further to this, partners have also systematised the criteria and procedures for professional qualification throughout Europe, whilst also acknowledging conditions and prescriptions for registration in non-European countries. Concurrently, partners have ascertained the level of awareness, knowledge and demands in terms of sustainable environmental design within the practice of architecture, and have benchmarked the needs and expectations of the building market. This task was performed via online surveys where practitioners were presented with a series of statements to which they had to express their opinion, respectively addressing sustainability in academic curricula, in continuing professional development, in regulations and in clients’ requirements.

A further section of the survey gave to respondents the possibility to comment in the form of free text on the main challenges and opportunities to the implementation of sustainability in professional practice. Some 400 surveys were collected from around 40 different countries. The outcomes of the initial stages of EDUCATE have been consolidated in two reports, encompassing the State of the Art of Environmental Sustainability in Academic Curricula and Conditions for Registration and the State of the Art of Environmental Sustainability in Professional Practice. These reports are downloadable from http://www.educate-sustainability.eu/state-of-the-art

CURRICULUM DEVELOPMENT

Following the consolidation of the state of the art, EDUCATE has elaborated a framework for curriculum development featuring a roadmap for the integration of sustainable environmental design at the different levels and stages of architectural education and post-professional training. Multi/inter/transdisciplinary contributions to programme innovation have been explored, together with the appraisal of applied and experiential learning techniques, new analytic visualisation and simulation tools, and the analysis of advanced insights from educational research. This task has also included investigation of e-learning tools, methods and technologies for delivery, applied learning, etc. Concurrently, partners have systematised the knowledge base of sustainable environmental design to be introduced at different stages of the education.
Education for sustainable environmental design should be founded on the most up-to-date knowledge deriving from research and built best practice, and should be informed by a critical analysis of the priorities required by the market, so as to bridge current divides between sustainability-related knowledge and creative design, and clearly define the abilities expected of graduates at each stage of their progression towards professional qualification. To these aims, the framework for the development of curricula of higher education has been elaborated to offer a conceptual support for articulating the design of programmes - yet, without specifying a detailed 'prototypical' curriculum in architecture, and therefore recognising the need for flexibility, autonomy, cultural diversity and innovation amongst academic and professional institutions. The *Framework for Curriculum Development* is available for download on [http://www.educate-sustainability.eu/educate-framework](http://www.educate-sustainability.eu/educate-framework).

**EDUCATE PORTAL**

In order to facilitate the achievement of the pedagogical objectives of the project, as well as for providing a tool to accomplish its proposed long-term impacts, EDUCATE has developed and tested an online Portal.

The EDUCATE Portal is an intelligent e-learning system aiming to facilitate the transfer of information, know-how and methodologies to students and professionals, and to provide interactive support towards the embracement of principles of sustainability and energy efficiency in architectural education and practice. Where possible, use has been made of existing software frameworks and components. However, no existing system (or combination of systems) could support the functional requirements of the EDUCATE Portal, therefore the development of new bespoke software has been required. Centred on a comprehensive Knowledge Base of sustainable environmental design, the Portal has been developed to facilitate interactions amongst groups of users. A description of its functionalities, as well as the results obtained during its testing, is available in the report *EDUCATE Portal Development and Testing* downloadable from [http://www.educate-sustainability.eu/portal-development](http://www.educate-sustainability.eu/portal-development).

**RESULTS OF COURSE AND CURRICULUM DEVELOPMENT**

Following the proposal of principles and strategies for curriculum development, EDUCATE has engaged in testing such pedagogical practices within design studio and continuing professional development (CPD).

In the initial phase of the testing, new and/or adapted course and module syllabi have been developed by the project partners. At this stage, a preliminary pilot study has been launched to test the pedagogies devised and evaluate the effectiveness of the teaching and learning methods adopted via the appraisal of a set of measurable indicators. In collaboration with regulatory bodies, building professionals have also simultaneously been invited to trial the use of the EDUCATE Portal to support CPD activities. The results of the pilot study have lead to further refinement of the pedagogical developments implemented by partners, and have informed a subsequent stage of analysis. During both testing phases, the secure access provided to students, academics and building professionals to the EDUCATE Portal has allowed users to access technical information, exchange knowledge, complete assignments, present their work, get feedback on design progress, and review the work of others.

The briefs developed and the results obtained are illustrated in the publication *Results of Course and Curriculum Development* available on [http://www.educate-sustainability.eu/results-of-development](http://www.educate-sustainability.eu/results-of-development).
EDUCATE PRIZE

In the context of the testing stages of the project, an International Student Award - under the banner of EDUCATE Prize - was launched, to which staff and students from European and non-European academic organisations - as well as from the EDUCATE partners - have been invited to participate.

The EDUCATE Prize aimed at rewarding student work creatively investigating and reflecting on sustainability in architecture and urban design. Also, the Prize was intended to value innovative pedagogical methods promoting sustainable design in curricula of higher education. The international character of the EDUCATE Prize, the non-restrictive nature of the brief, and the diversification between levels of entry, have been arranged to reflect the variety of approaches that characterises contemporary architectural education. Academic members of staff from Faculties, Schools and Departments of Architecture (or related discipline) worldwide have been able to register their module, course or design studio to the EDUCATE Prize and submit maximum one entry under each of three Categories. Academics registering to the Prize were given free access for themselves and their students to the EDUCATE Knowledge Base, so as to support dissemination of know-how and best practice of sustainability.

The assessment process of the Prize has involved an independent Jury composed by members of European professional institutions and international architects. A presentation of all awarded projects is available in the EDUCATE Prize Catalogue, downloadable from http://www.educate-sustainability.eu/prize-catalogue

WHITE PAPERS

The results obtained throughout the three years of development of EDUCATE have informed, in its final stage, the formulation of principles towards education for sustainability in architecture and the proposal of clear conditions for accreditation of curricula and for professional registration. To this aim, partners have validated the results obtained during the testing, whilst also acknowledging feedback from stakeholders (e.g., advisory boards) in order to refine the pedagogical and regulatory criteria proposed.

The outputs of these activities have been consolidated, on the one hand, in a white paper on Sustainable Architectural Education, which presents principles and practices - illustrated in terms of mission agenda, learning outcomes, programme structure, methods for teaching and learning, and strategies for transfer of the pedagogy - to foster the implementation of sustainable environmental design at different stages of architectural education. Far from advocating the standardisation of pedagogies, this white paper is intended to offer guidelines in curriculum development towards the embracement of sustainability in academic programmes.

Concurrently, working in collaboration with Chambers of Architects, partners have formulated strategies for the development of consistent Criteria for Professional Qualification informed by - and aiming towards - sustainable environmental design. The criteria proposed in this white paper have been formulated in accordance with (and complementing) the Directive 2005/36/EC of the European Parliament on the mutual recognition of professional qualifications across European member states, yet still allowing some flexibility for them to be potentially embraced by regulatory bodies in different countries at a global level.

The two white papers are available for download from http://www.educate-sustainability.eu/white-papers
State of the Art of Sustainability in Higher Education

The analysis of the state of the art of environmental sustainability in higher education and in the conditions for accreditation and professional registration has constituted the first stage of the EDUCATE project, aiming to build a comprehensive picture in terms of the integration of environmental sustainable design and energy efficiency in current academic pedagogies and in the criteria that control access to the practice of architecture and urban design. This task has been performed through analysis of current curricular structures, course syllabi, delivery methods, assessment criteria, etc. within architectural-accredited degrees at partner institutions, at selected academic organisations in participating European member states, and in a number of other European and non-European countries. This has allowed the systematisation of the current state of play and has facilitated the development of a framework for curriculum development successfully embedding principles and values of sustainability in the education and practice of disciplines of the built environment. Specifically, the activities of the first stage of EDUCATE have led to the following outcomes:

- Detailed description of architectural-accredited degrees at the seven partner academic institutions;
- Significant exempla of architectural curricula per each of the six European participating countries (United Kingdom, Belgium, Germany, Italy, Spain, Hungary; 29 curricula);
- Paradigmatic models of architectural curricula in 16 non-participating European countries (23 curricula);
- Exempla of architectural curricula in seven selected non-EU countries (10 curricula);
- Criteria for accreditation of academic curricula and conditions for professional registration in 22 European countries and in seven selected non-European countries.

To conduct this analysis, partners have reviewed material published by the selected academic and professional institutions (e.g., web sites, yearbooks, pedagogical publications, conference and journal papers, works of students, etc.) and have obtained direct feedback from local academics and representatives of regulatory bodies. Each curriculum/country analysed has been reviewed under the following headings:

- **Name and Duration of the Course and/or Degree**: distinguishing between undergraduate (generally, 3 years), graduate (generally, 2 years) and postgraduate (1 or more years) degrees, following the structure of higher education established by the 1999 Bologna Declaration (EHEA, 1999);
- **Accrediting Body**: indicating the organisation delegated to evaluate, on behalf of the higher education and professional sector, the status, legitimacy and appropriateness of a course and/or a degree;
- **Educational Aims**: highlighting the targets of a specific course/degree, basing on the structure and overall educational and professional aims of the hosting institution;
- **Outline Description of the Course**: emphasising the organisation of the course, the pedagogical objectives to be achieved at each level of education, and the different options available to the students;
- **Course Structure**: illustrating the educational path of the programme, the modules (core, optional and electives) at each year of progression, the credit structure, specialist and advanced teaching, etc.;
- **Learning Outcomes**: describing the knowledge, skills and competence expected upon successful completion of the programme and the further training/examination needed for professional qualification;
- **Sustainable Environmental Design in the Academic Curriculum**: illustrating the academic units of teaching that specifically focus on themes of environmental sustainability (design studio and/or ex-cathedra modules), including description of contents, delivery and assessment methods;
- **Integration of Sustainable Environmental Design with Studio**: visualising in a simplified graphical manner the structure of the course, and indicating the level of integration of technical taught contents with design applications basing on a satellite, partially-integrated or fully-integrated structure;
- **Strengths and Opportunities**: highlighting - basing on direct feedback from local academics - existing assets, qualities, advantages and opportunities of the pedagogies adopted;
- **Summary of Criteria for Accreditation and Professional Qualification**: describing how the curricula are related to national accreditation requirements and the existing conditions for qualification and registration with indication of the knowledge, skills and competence requested for professional practice.

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1 The data collected refer to the Academic Year 2009-10. The report *State of the Art of Environmental Sustainability in Academic Curricula and Conditions for Registration* is available on [http://www.educate-sustainability.eu/state-of-the-art](http://www.educate-sustainability.eu/state-of-the-art)
Amongst North European countries, in the United Kingdom the achievement of professional qualification involves a combination of academic studies and practical experience, and takes a minimum of seven years to compete. This includes three key stages of study on recognised courses (Part 1, 2 and 3) validated by the Royal Institute of British Architects (RIBA). There is a long tradition of sustainable environmental design education in UK, especially at postgraduate and post-professional level. At present, architecture is taught in different ways across more than 40 British schools of architecture, although most of the curricula are based in the studio for design work, tutorials and critiques. Almost all of these courses feature some aspects of sustainable environmental design, since the implementation of these principles is required as part of the accreditation and validation process. There are also several post-professional degrees offering specialised education in aspects of sustainability. Seven UK schools were selected for the analysis of the state of the art: the University of Nottingham; the Architectural Association School of Architecture; the University of Bath; the University of Cambridge; Cardiff University; the Glasgow School of Art; and Oxford Brookes University. There seems to be a clear awareness in all these schools of the need to do more in order to better integrate the theory and practice of environmental sustainability in meaningful architectural design, although the applied methodologies can differ substantially. At some schools, sustainable environmental design is taught as a compulsory core module, whilst in others some components can be optional. Conversely, although environmental principles and practices have been traditionally taught as stand-alone satellite contents, there is a general tendency for these subjects to be more and more integrated within design studio modules. Environmental awareness, together with knowledge of principles of sustainability, also features widely among British building professionals. This is especially the case in the larger architectural practices, most of which now have their own sustainability teams, as well as involving external specialist consultants.
In Ireland, the structure of architectural curricula is similar to the UK, also considering that programmes accredited by the RIAI (Royal Institute of Architects of Ireland) are generally also accredited by the RIBA. After two years of approved practical experience, holders of a 5-year degree in Architecture are entitled to take the examination for the Certificate in Professional Practice and Practical Experience, which gives exemption from the examinations in Professional Competence of the RIAI and the RIBA Part 3, and qualifies for membership of both institutes. The academic curriculum analysed at the University College Dublin revealed that environmentally-oriented modules, particularly at undergraduate level, are generally delivered through satellite lectures and are assessed by a final examination and/or a project study involving computer-based modelling. It is worth noting that throughout the undergraduate course, technology principles and applications are introduced and analysed to provide a foundation for an understanding of the construction methods and performance of a building, and part of the assessment is allocated to design projects. Conversely, at graduate level, themes of sustainable design tend to be more integrated with design studio.

**Structure of the BSc (Architectural Science) at the University College Dublin, Ireland (Academic Year 2009-10)**

Sweden should be singled out as having a strong tradition in the field of environmental education that shares a great deal with the UK experience. The curriculum at the KTH Royal Institute of Technology highlights the presence of specialised studio modules on sustainable environmental design to be chosen as an option in the final years of the course. Conditions for qualification include a requirement for at least one year of professional practice. Conversely, the architectural programme investigated at the Aarhus School of Architecture in Denmark reveals that, although no explicit reference is made to sustainable environmental design within the structure of the pedagogy, these issues are integral to the delivery of the programme, with specific reference to design studio projects. Conditions for qualification for Danish graduates require evidence of professional practice resulting from training after completion of the higher education course.

In Central Europe, in Belgium, France and the Netherlands sustainable environmental design is not new to architectural education, since notions of solar architecture and bioclimatic design have been included in the curriculum of some schools for almost 30 years. Initially, these contents were related to an ecological dimension of architecture and were often developed in dedicated research groups such as: Architecture et climat (Université Catholique de Louvain), Ceraa (Institut Supérieur d’Architecture Saint-Luc de Bruxelles), CRESSON and CRAterre (École Nationale Supérieure d’Architecture de Grenoble), GRECO (Ecole Nationale Supérieure d’Architecture de Toulouse), etc. Although environmental considerations were not initially embraced by all the actors of the academic and construction sector, however, at present, things seem to move with the current environmental context. The analysis of the state of the art shows that schools are embracing mainly three strategies for the introduction of sustainable design in their curriculum. The first strategy is the creation of compulsory (and/or elective) satellite technical modules that meaningfully support the design development, particularly in undergraduate degrees (e.g., the Technical University of Delft). The
second approach is oriented towards the creation of optional integrated studio modules and/or specialist Master/graduate degrees where sustainable design is distilled throughout the progression of design exercises and other coursework. In some cases, students can choose a specific Minor (i.e., a series of dedicated thematic teaching units) during their degree and/or a specialised Master (e.g., the Climatic Design Minor and the Master Degree in Physics of Built Environment at the Technical University of Eindhoven; the Minor in Sustainable Design and the Master Degree in Architectural Engineering at TU Delft). Besides some compulsory modules delivering the basic notions of sustainable design, these options/orientations generally propose a strong education focusing on environmental sustainability in architecture. However, due to their optional nature, it is also possible for students to choose different pedagogical paths and therefore complete their degree without having comprehensively considered sustainable environmental design. Nevertheless, a third strategy seems to be the most relevant in these countries and corresponds to a holistic approach introducing the themes of sustainable environmental design in the whole educational programme, in theoretical courses as in design studios, and at various levels of design intervention. Yet, the interactions between the theoretical courses and their application in design studios can vary significantly. In terms of conditions for qualification, in Belgium a professional training (stage) of minimum two years is obligatory for the practice of architecture, whilst in France and the Netherlands a period of practical training experience is not compulsory for registration as architects, although highly recommended. In both these latter countries, continuing professional development and life-long learning is however required for professional practice.

In Germany and Austria, environmental awareness is well developed, and both countries have a number of schools that teach sustainable design with meaningful learning outcomes. This corresponds to a high level of building standards that focus on energy efficiency, such as the Energieeinsparverordnung (Energy Saving Code) in Germany, and the Richtlinie für Energieeinsparung und Wärmeschutz (Guideline for Energy Saving and Thermal Insulation) in Austria. As an example, the University of Stuttgart and the Technical University of Munich have pioneered the concept of energy efficient buildings throughout the last 30 years. Nevertheless, schools of architecture have introduced the Bologna process only recently, making it hard to find comprehensive results on the implementation of this new curricular structure. Architectural courses usually integrate the subject of sustainable environmental design both at Pre-Diploma and Diploma level. Curricula are relatively open in terms of the contents of their education, yet with an apparent dependency on the personal interest and focus of individual Professors and their Academic Department. Sustainable environmental design is usually taught within building physics, building services, building construction and urban design. Exploration in architectural design is achieved by cross-department seminars and integrated studio modules. Further to this, some universities offer postgraduate courses that specifically focus on sustainability and energy efficiency. In both Germany and Austria, graduates obtain professional qualification after two (three for Austria) years of practical experience. In Austria, an additional exam is required.
Poland, Czech Republic and Slovakia have recently adapted their academic curricula to the Bologna process and also offer their courses partly in English. Sustainable environmental design is generally included in all undergraduate and graduate degrees. The level of integration of the subject varies widely, from it being the focus of whole departments (e.g., at the Slovak University of Technology in Bratislava), to a more sparse diffusion across the curriculum. Conditions for professional qualification generally require, after completion of a graduate degree, three years of certified practical training and a professional examination.

In Southern Europe, the teaching of architecture in Italy reflects a variety of approaches in terms of curricular structure and delivery of contents of environmental sustainability, due to a high number of degrees on offer. The variety of programmes is further amplified by the current transition derived from the application of the Bologna process; therefore, the implementation of sustainable environmental design and energy efficiency in the educational progression towards professional qualification is rather diverse. As an example, at postgraduate level, the University La Sapienza is one of the several institutions offering a professional 1-year Master degree fully focusing on environmentally conscious design, eco-efficiency and sustainable processes, renewable energies, systems and technologies, etc. Amongst other institutions, the University of Ferrara offers a 5-year degree where principles and practices of environmental sustainability are taught in modules that are partially integrated in the structure of the design studio. Other universities impart degrees where environmental design occupies a more explicit role in the educational agenda, as the Polytechnic of Milan, which offers a dedicated undergraduate degree in environmental architecture. In the programme, design is developed at all different scales and is related to environmental quality and sustainability of transformation processes via the integration of specialist teaching units within design studio modules. In Italy, professional qualification can be achieved in two stages (Junior Architect after the undergraduate degree, and Architect at completion of 5 years of graduate studies) and requires a theoretical and practical national examination.

Structure of the Bachelor in Environmental Architecture at the Milan Polytechnic, Italy (Academic Year 2009-10)

In Greece, the architectural curriculum is generally structured in a 5-year graduate Diploma degree, where specialist modules focusing on environmental sustainability (compulsory or optional) are offered in support of design studios. The curriculum analysed at the National Technical University of Athens is rather design-oriented and reveals the presence of both core and elective modules centred on principles of environmental sustainability, with particular reference to their application in urban and regional planning. Professional qualification is achieved following an examination. Higher education programmes in Slovenia, Croatia and Cyprus currently present both a 3+2 or a 5-year structure, whereas at least one specialist core module on sustainable environmental design is generally offered in the curriculum (often with a specific technical bias), supported by several optional teaching units (in some cases available as summers schools as). Practical experience, from one (Cyprus) to three (Croatia) years, is requested for professional registration.
In Western Europe, **Spain** has in recent years adapted its academic curricula to the Bologna process. Due to this situation, environmental contents in teaching have not yet fully been implemented and tested, both at undergraduate and graduate level, although several consolidated exempla are to be found at postgraduate level. Yet, the methodological structures proposed by some architectural programmes show some meaningful opportunities. This is the case, for example, of the University of La Coruña where teaching is approached through the ‘workshop’ (an integrated design studio) as a learning tool. The workshop is a space to exchange knowledge conceived to facilitate the confluence of contents of different subjects around the architectural design project. The aim is to ensure optimization of teaching resources and rationalization of student work, therefore also offering significant opportunities for implementation of environmental issues. This curricular structure is being followed by other schools of architecture. In terms of conditions for registration, the Consejo Superior de Colegios de Arquitectos de España is responsible for licensing architects if they comply with the requisites of the Spanish Law and the European Directives. In **Portugal**, environmental issues are generally introduced in a very little systematic way through specific modules taught by conscious teachers, although there is generally a lack of comprehensive integration of these topics at a curricular level. Two years of practical training following the graduate studies are requested for registration.

In Eastern Europe, **Hungary**, **Bulgaria** and **Romania** are aligning their curricula to the Bologna process, although some institutions - such as the Budapest University of Technology and Economics - also offer a 5-year (or 6-year) graduate Master degree in architecture, articulated in two consecutive cycles of study. At the early stages of the programme, students develop their knowledge in technical fields and are introduced to principles of bioclimatic architecture, human comfort and energy efficiency. The teaching generally also includes analysis of European and national energy regulations, so as to provide the theoretical background necessary to comprehend the idea of energy conscious design. During the subsequent years of education, optional modules introduce specialist knowledge in a more systematic way to support design applications. Registration requires a period of practice, whose duration varies according to the level of qualification.

Amongst extra-European countries, in **Switzerland** the Ecole Polytechnique Fédérale de Lausanne offers a 3-year undergraduate degree, whose programme includes one parallel satellite module in building physics per each semester of study, thus conveying all the theoretical background needed for application in design. After completion of the Bachelor degree, students must undertake a 12-month period of validated practice at an architectural firm, following which they have access to a 2-year graduate Master programme structured in compulsory courses, design projects and electives, a specialization or a Minor, and a thesis. Minors could have a specific emphasis on sustainable design, therefore leaving to the students the capacity of deepening their interests in the field amongst a number of other options. Access to the profession is granted to graduates with a Master degree (or equivalent qualification) and with at least 3 years of practical experience.
In the **United States of America**, at least eight years of a combination of education and training are needed to practice architecture, together with passing a professional registration examination. The duration of higher education programmes can vary, since they can be organised on the traditional 4+2 (or 4+3)-year structure or, in specific cases, they can be constituted by a condensed 5-year course (e.g., at the Illinois Institute of Technology in Chicago), yet being accredited by NAAB (National American Accrediting Board). In terms of implementation of sustainable environmental design, the structure of the curricula generally includes compulsory satellite modules (particularly at undergraduate level), which impart general knowledge on the physical principles and concepts associated with buildings and environment, and introduce a variety of building support systems. Sustainable design is also integrated in a number of advanced design studios, particularly during the last years of the curriculum (Master degrees), and represents the focus of various electives from architectural departments, from other majors, or from social/liberal arts optional education courses. In some cases, as for example at the University of California - Berkeley, students are able to take up to one-quarter of their curriculum as electives. Most curricula also leave to the students the possibility to pursue a Minor in a department different from architecture. Minors generally consist of at least five modules and are frequently cross-disciplinary. In some cases, schools also offer combined tracks that bring together Master degrees with postgraduate courses in order to provide a detailed specialisation in a discipline. This is the case of the MSc in Architecture-Sustainable Design track offered by the University of Minnesota.

In **Canada**, the two-stage Bachelor + Master curriculum at McGill University complies with the requirements of the Canadian Architecture Certification Board (CACB), and is also accredited by the NAAB in the USA. The programme is structured as a four-and-a-half-year, or nine-term, course divided into a six-term design-based curriculum, and a three-term or four-term professional degree, which can be focused on design studio coursework or directed research. The nature of the course is relatively flexible and leaves the opportunity for students to take a number of complementary courses within the Department of Architecture or from other disciplines, which could take a specific focus on sustainable design. To achieve qualification in Canada, holders of a graduate degree must have sufficient pre-registration practice (a minimum of 5,600 hours of mandatory and discretionary experience) - typically gained by an internship - and pass an exam.

In **Mexico**, amongst the various programmes investigated, at the University of Colima sustainable design plays a pivotal role in the structure of the curriculum, and the training is based upon environmental topics that can stimulate the attainment of an ecological sensitivity in the formation of future architects. Environmental aspects, together with those of habitability, appear transversely throughout the degree, therefore fostering a consistent education in sustainability and the capacity of application in the future professional practice. There are various integrated studio modules focusing on sustainable environmental design in the intermediate years, which provide important guidelines for the progression to the following stages of education.
In Brazil, the curriculum at the Faculty of Architecture of Sao Paolo is characterised by a satellite structure of delivery, with contents of environmental sustainability being generally imparted via a lecture series and assessed separately from design studio. The teaching of principles and strategies of building physics is typically conveyed as part of the modules offered by the Department of Architectural Technology to be taken in the first four years of the degree, with the fifth year being dedicated to optional units and the design thesis. Conversely, themes of ecology, social sustainability and applications to design case studies are normally introduced as part as the modules offered by the Department of Project. To achieve professional qualification in Brazil, a graduate needs to provide to CONFEA (Federal Council of Architects) a full academic record.

In Singapore, the structure of the curricula and the professional qualification process is similar to the UK, also in consideration of the fact that RIBA gives validation to the programmes. In particular, at NUS (National University of Singapore) students wishing to enrol to the graduate 1-year Master course require an additional year (Honours Year) after having obtained a RIBA Part 1 undergraduate 3-year degree. The honours year is offered under different tracks. Holders of a graduate degree are awarded RIBA Part 2 accreditation and, after no less than two years of architectural practice, can apply for professional registration in Singapore. The implementation of sustainability is generally done via satellite modules in the undergraduate degree, covering the principles of environmental responsive architecture and focusing on passive modes and other low energy strategies (with specific emphasis to tropical architecture). Further opportunities are offered by electives that students can choose at various stages of their progression. Other than the 1-year graduate Master degree, NUS also offers a MArch option with specialisation in Design Technology and Sustainability.

In Australia, graduates of an architectural degree are required to complete two years of practical experience under the supervision of a registered architect in order to apply for registration with the local Architects Registration Board and the Australian Institute of Architects. At Deakin University, in addition to the traditional accredited 5-year path Bachelor + Master of Architecture, students have the opportunity to enrol in a distinctive undergraduate Architecture/Construction Management course which can be taken in 5 years (or 4 years under the accelerated curriculum) and that is then followed by a 1-year graduate Master of Architecture. Specific emphasis to the themes of environmental sustainability is given within the undergraduate degree, where the contents are generally imparted in satellite lectures and are then transferred in design studio. Compulsory modules cover the environmental significance of materials within the framework of sustainability and embodied energy, the climatic and environmental factors that influence the design and construction of buildings in the context of an ecologically sustainable development, and the range of building services used primarily in commercial buildings. At Master level, further obligatory modules examine thermal, visual and aural environments through a series of case studies and practical applications.
Benchmarking Professional Demands

A GLOBAL ENQUIRY OF PROFESSIONAL PRACTICE

In parallel with the analysis of the state of the art of environmental sustainability in higher education and in conditions for registration, in its initial stage EDUCATE has conducted a global appraisal of awareness, knowledge and requirements of sustainable environmental design amongst architectural firms in European and extra-European countries. These activities have been performed through online surveys distributed to professionals, in which practitioners were asked to express their opinions and rate priorities with reference to their experience and approach to sustainability in the practice of design. Based on a statistical evaluation of the results (some 400 surveys have been collected from 40 different countries), a critical analysis has been conducted to extrapolate, per each context of analysis, the barriers and opportunities for the successful embracement of sustainability in the building industry, whilst also prioritising market demands.

Sustainable Environmental Design represents a core part of the design approach of your practice

Exempla of Consolidated Results from the Online Survey

In Northern Europe, the results of the survey in United Kingdom, Ireland and Denmark confirmed that most practitioners perceive sustainable environmental design as a source of creative inspiration from the initial stages of design and are conscious of the responsibilities it entails. Architects in these countries think that environmental sustainability should be a compulsory requirement for professional qualification, and should be consistently included in curricula of higher education to respond to market expectations. Such commitment should also be reinforced by continuing professional development and comprise dissemination of knowledge to the public, also in view of new regulations and governmental initiatives. Existing legislation is generally considered as being supportive to sustainable practices, yet with room for improvement. A further important role must be played by clients, which - although increasingly conscious of the opportunities offered by sustainability - are still often driven mainly by demands for aesthetical appearance and reduction of costs.

The main barriers to the implementation of sustainable design practices can therefore be summarised in:

- Costs (or perception of them, by designers, clients and developers);
- Loose regulations, lack of long-term vision and scarcity of adequate financial incentives;
- Lack of confidence in sustainable solutions, ambitious claims and conflicting information on performance;
- Insufficient training to promote multidisciplinary education for designers, builders, consultants and clients.

The idea that sustainable solutions are more complex and expensive, or can be a limitation to good design, is still diffused amongst clients and other actors of the building market. In terms of educational development, therefore, it is essential that sustainability and architectural design are not considered as separated entities. Sustainability is not just about energy efficiency, but rather a complex and overarching multidisciplinary field that requires appropriate expertise, as well as a moral obligation and an opportunity for inspired architecture.

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2 The comprehensive results are published in the EDUCATE report State of the Art of Environmental Sustainability in Professional Practice, downloadable from http://www.educate-sustainability.eu/state-of-the-art.php

3 Detailed outcomes of the surveys in specific countries are available in the EDUCATE document Benchmarking of Professional Needs, available on http://www.educate-sustainability.eu/benchmarking-professional-needs.php
In Central Europe, environmental awareness and responsibility are rapidly spreading amongst building professionals in Belgium, the Netherlands and France, who start to consider sustainability as a source of inspiration and an ethical commitment, particularly at the initial and specification stages of the design process. Professional competence in sustainable design is considered as paramount for architectural practice and should be provided at pre-and post-professional level, although not always architects seem to hold confidence that higher education institutions and regulatory bodies have the necessary capacity to offer such expert training. Amongst the priorities for the implementation of sustainable design in practice are:

- More precise information to the public (specifically in terms of costs and innovation in design);
- Remove cultural routines that often ignore the possibilities offered by sustainability;
- More stringent regulations and standards, whose application should be more strictly verified.

In Germany and Switzerland, architects show significant consciousness of sustainable environmental design, which is considered an important requirement to enter the professional market. For many it represents a core part of the design ethos and a potential source of inspiration, although a number of respondents declared not to be too confident in the creativity inherent in sustainability. These results have to be considered in the context of the existing stringent legislation on energy efficiency of buildings. This is also reflected in the strong expectations towards regulations - that could be improved to foster creativity in environmental solutions - as well as the confidence given to governmental institutions and professional bodies in promoting sustainable practices and providing proper education. Concerning clients' requirements, costs still represent a primary concern, whilst ethical mindsets play a very marginal role. As a consequence, the public should gain better knowledge of sustainable design and behaviour, whilst regulations should facilitate innovation and design opportunities in support of new means of architectural expression.

In Southern Europe, architects in Italy, Spain and Portugal show growing awareness and interest in sustainability and the creative inspiration it could bring to the design process, even if there still are misconceptions and/or misunderstandings amongst professionals. This consciousness is revealed also in the belief that sustainable environmental design should be part of the education of building practitioners, although such requirement is not yet consistently considered as compulsory for entering the construction industry. Competence and skills should be enhanced by the promotion of expert training, even though there is still a certain lack of confidence in the training provided by academic and professional bodies. Amongst the barriers still existing to the successful implementation of sustainable design in the practice of architecture:

- Lack of adequate culture in clients, often concerned exclusively with the minimisation of capital costs;
- A fragmented and highly bureaucratised regulatory framework, and a lack of vision by the government;
- Lack of appropriate financial incentives, which reduces the chances of investment in innovative design.

In Eastern Europe, Hungary, Romania and Bulgaria share comparable outcomes. Designers generally support the requirement for sustainability to be consistently included in the training of professionals starting from the early stages of higher education, and, in most cases, they consider such approach as being core to their design ethos. Informed knowledge of sustainable principles should be required to access architectural practice and should be further deepened through expert training offered by regulatory bodies. In order to realise successfully the opportunities presented by environmental sustainability, a strong responsibility is held by the government, whose regulations still fail to comprehensively promote its effective implementation. Obstacles to overcome to support sustainable practices are represented mainly by:

- An inadequate legislative structure;
- Need for clear and consistent information that builds on traditional skills, exempla of best practice and an interdisciplinary insight, to allow transfer of knowledge between different professional domains.
- Lack of communication between the architectural profession and the government to facilitate political decision-making, more appropriate standards and bridge the gaps between contrasting interests.

Amongst extra-European countries, in Canada and in the United States of America there is increasing consciousness about the potentials offered by a sustainable approach to design, this representing a core part of the ethos and methodology of dedicated firms. Canadian and American architects believe that sustainable design should sit at the core of architectural education, and that competence in this area should
be compulsory for qualification, although currently such demand is not considered mandatory for accessing the building market and should be further reinforced by professional development. To promote sustainability in the practice of architecture, a key role should be played by the government, also considering that current regulations are not always proficient in guaranteeing such integration. Public and private clients are increasingly aware of the opportunities offered by sustainability, even if more information is needed to sensitise the community to the broad environmental/ecological/ethical agenda, combat the practice of greenwash and prevent the existing 'fear factor' with respect to sustainable solutions. Amongst the priorities:

- Education to raise clients’ and developers’ awareness, and shift thinking from profit-driven cultural norms;
- Definition of appropriate policies, regulations and codes.

In Latin America (Mexico, Chile, Brazil), architects do not yet seem to be consistently conscious of the opportunities offered by environmental sustainability, although for dedicated practices sustainable design is a creative input to architecture and influences choices particularly at the early stages of design development. Skills of environmental sustainability are not strictly requested to enter the building market, although such professional competence could be reinforced via courses provided by regulatory bodies. The priorities for a comprehensive embracement of sustainability in architectural design can be summarised in:

- A more suitable legislative framework that create real drivers and demands;
- A scientific rather than empirical approach to sustainability that can promote innovation and creativity;
- More education for the public, so as to prevent frequent misconceptions, cultural prejudices and existing mindsets that prioritise saving money at the time of investment rather than looking at long term benefits.

In China, respondents of the survey manifested their commitment towards sustainability and the opportunities offered by a design approach based on passive design strategies, comfort and energy efficiency. However, such dedication is only partially shared by clients, developers and stakeholders in general, with a building market not yet consistently requiring such skills to enter the professional practice. Clients’ requests are still mainly driven by priorities concerned with reduction of investment costs, financial incentives and aesthetic values, while governmental policies and regulations are yet inadequate to support the implementation of sustainability in the practice of design. Amongst the main barriers to tackle:

- Need for a clearer and more stringent legislative framework;
- Remove clients’ common perception that sustainability is complex and expensive;
- Reinforced education for architects, builders, developers and policy-makers;
- Avoid the habit of poor construction methods, short times of design and low budgets.

In Singapore, architects find creative inspiration in environmental sustainability throughout the various stages of the design process, predominantly in terms of application of passive principles and attention to aspects of social sustainability (including cultural and religious differences). Singaporean architects strongly believe that environmental sustainability should be a central part of architectural education and be compulsory for professional qualification. In supporting the implementation of sustainable design, a responsibility lies in governmental institutions, although existing regulations seem to provide a sufficient framework to promote such implementation. Nevertheless, a too prescriptive legislative structure (e.g., a rigid application of the Greenmark standard) could entail the risk of constraining creativity in design. Ecological and ethical issues, however, very rarely represent a design driver particularly for private clients. As a consequence, awareness of environmental responsibility should be better promoted, so as to overcome existing knowledge barriers and dichotomies of visions and intents - that also involve some of the actors of the building market (e.g., developers) - and to effectively support changes of attitude and expectations.

In Australia, architects seem consistently aware of the mandates of sustainability and the creative inspiration it can bring to design, and this belief is shared also by the majority of public and private clients. Nevertheless, more accessible and clear information for the general public - as well as for investors and developers - is required to promote further changes in behaviour and habits. A substantial education on the principles of sustainability is considered necessary to enter the professional market and should therefore be consistently included in architectural curricula. This should also be supported by an appropriate legislative framework, incentives, standards and regulations, so as to facilitate the achievement of a longer-term vision.
Framework for Curriculum Development

A ROADMAP TO SUSTAINABLE ARCHITECTURAL EDUCATION

Education for sustainability is an emerging imperative, requiring a significant review of the way in which younger generations are taught within academic institutions and in post-professional training. The United Nations Decade of Education for Sustainable Development calls for Universities to “function as places of research and learning for sustainable development” (UNESCO, 2009). To this aim, priority should be given to the development of sustainability literacy as a ‘core competence’ amongst learners. Programmes of higher education should move away from ‘reductionist’ approaches towards fostering critical and holistic thinking, lifelong learning and making multidisciplinary connections between different cognitive domains (HEA, 2005). Nevertheless, several misconceptions still hinder the achievement of such objectives, starting from misleading terminology that is often ‘attached’ to academic courses, often without a precise meaning. The much abused term sustainability has to go beyond the natural environment alone, embracing at once several aspects of human activity that include economic, social, cultural, ethical and aesthetic values in addition to the technical issues of energy consumption, resource management and CO₂ emissions (WCED, 1987).

In the field of architecture, awareness of the role that built environments play in the current climate crisis is bringing to the fore new responsibilities for educators and practitioners. However, regardless of the significant corpus of knowledge produced by scholarly research, several pedagogical barriers still hinder the comprehensive implementation of sustainability in academic programmes. Concurrently, the promotion of sustainable design practices is not yet consistently supported by regulatory institutions, whose prescription criteria are still often characterised by ambiguous requirements, especially in ascertaining an effective integration between creative and technical abilities. A reconsideration of academic and professional training is thus needed to bridge the gap between theoretical sciences and their practical design applications.

A global analysis highlights that the promotion of sustainability in the formation of building practitioners is a theme that sits at the core of the activities of many higher education and regulatory institutions. Founded on the analysis of the state of the art of academic pedagogies and on the demands of the market, it is therefore possible to define a roadmap towards education for sustainability in the built environment that can offer an underlying support to programme development and promote the integration of sustainable environmental design⁴ in the training of architects and other actors of the building industry. Obviously, this roadmap should not aim towards the definition of a prototypical curriculum, but rather maintain sufficient flexibility for it to be adapted to a diversity of contexts, pedagogical systems and approaches. Basing on a mission agenda embracing a commitment towards sustainability, the learning outcomes expected of graduates should be formulated on a scale that encompasses both conventional design principles and those of environmental performance. Such learning outcomes should be related to the systematisation of a broad cognitive framework of sustainable design, and should be combined with the identification of best practice in programme structure and the exploration of pedagogical methods that can facilitate knowledge transfer⁵.

MISSION AGENDA AND LEARNING OUTCOMES

A curriculum development aiming towards education for sustainability should be based on an institutional vision that values sustainable development as a priority from the beginning of the studies. This requires that academic and professional institutions are all fully committed to this priority, enthusing and inspiring staff and students to sustainable practices and behaviour through appropriate educational methods and tools and the allocation of adequate research, human, financial and temporal resources. In architecture, educating for

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⁴ The term ‘sustainable environmental design’ - hereafter used to characterise the aims of education for sustainability in the disciplines of the built environment - derives from the definition given in the Architectural Association’s MSc & MArch Sustainable Environmental Design Programme Guide as “the means by which heating, cooling, ventilation and lighting” can be provided in buildings to achieve comfortable conditions for occupants, “displacing the use of non-renewable energy sources and conventional building service engineering by self-sustaining processes that are inherent in the built form, elemental specification and operational schedules of buildings” (AA, 2010).

⁵ The Framework for Curriculum Development is available on http://www.educate-sustainability.eu/educate-framework
sustainable environmental design should prioritise the development of critical awareness and reflection on the interdependencies between disciplines, and support investigative discourse between the parties involved in the design process, whilst contributing to the advance of knowledge through exemplar research and lifelong learning. A programme of higher education successfully implementing environmental sustainability should be built on the analysis of the barriers and opportunities required by the market, so as to define the knowledge, skills and competence expected of graduands, graduates and practitioners. These learning descriptors derive from the European Qualifications Framework for Lifelong Learning (EQF), a reference educational framework adopted in 2008 by the European Commission to link countries’ qualification systems. Compatibly with the Bologna structure of higher education in Europe and the Framework for Qualifications of the European Higher Education Area (FQ-EHEA, 2005), the EQF structures teaching and learning in 8 levels spanning the full scale of qualifications (where level 6, 7 and 8 correspond respectively to the three cycles of higher education - undergraduate, graduate, and postgraduate - as per the Bologna process) and describes the learning outcomes as “a statement of what a learner knows, understands and is able to do on completion of a learning process” (EC, 2008). In the EQF, learning outcomes are defined in terms of:

- **Knowledge**: which describes the “outcome of the assimilation of information through learning”. It can be “theoretical and/or factual” and is constituted by a “body of facts, principles, theories and practices”
- **Skills**: which indicates “the ability to apply knowledge and use know-how to complete tasks and solve problems”. In the EQF, skills are described as cognitive, “involving the use of logical, intuitive and creative thinking”, or practical, “involving manual dexterity and use of methods, materials, tools and instruments”
- **Competence**: which is characterised as “the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development”

Although the taxonomy of learning outcomes can be somewhat different between the EQF, other educational frameworks (e.g., the Dublin Descriptors used to qualify pedagogical attainments in the FQ-EHEA; JQI, 2004) and national disciplinary benchmark statements - as the QAA Subject Benchmark Statement Architecture 2010, adopted in UK by the ARB and the RIBA and founded, as in every other European country, on the 11 points that form part of Article 46 of the Directive 2005/36/EC on the Mutual Recognition of Professional Qualifications (EC, 2006) - the achievements described remain largely similar, thus reference is here made to the EQF to ensure ample transferability of the proposed learning outcomes. Evidently, pedagogical objectives aiming at the inclusion of environmental sustainability within creative design need to be considered at a wide-ranging level since they also ought to respond to differences between curricular models and legislative demands across countries. Learning outcomes should however be clearly related to the acquisition and exploration of a broad cognitive framework of sustainable environmental design.

**COGNITIVE FRAMEWORK**

A solid theoretical background should provide students and practitioners with the ability of converting physical laws in creative architectural forms. The translation of building science into meaningful design, however, has also to be supported by empirical understanding and evidence-based learning, so as to reveal how different principles can be applied into practice, and by analytic tools and simulation techniques that can facilitate the testing and evaluation of different hypotheses and make performance predictions from the early stages of design. These three domains - theoretical, empirical and analytic - should be delivered simultaneously in higher education curricula, without being marginalised as specialist or technical studies.
For such priorities to be consistently included in academic programmes, it is necessary to evaluate how the knowledge needed for their implementation can inform the education of practitioners of the built environment. To this aim, an integrated cognitive framework is proposed, where the knowledge associated with sustainable environmental design can be systematised under: Issues and Principles; Applications and Case Studies; and, Tools. Each domain has its own distinct character and purpose, while also being an essential constituent of the other two. All three should be relevant at each stage of the curriculum, although the form that each may take, the pedagogical methods applied and the level of competence acquired can vary.

**Issues and Principles**

The domain of Issues and Principles can be organized into spheres of knowledge that include basic principles and exempla of systems and solutions, addressing global sustainability challenges and their local expression in architecture and urban design. The knowledge featured in these spheres stems from physical, physiological and psychological notions that can be employed to elaborate the appropriate bioclimatic strategies necessary to guarantee the adaptive comfort and well-being of occupants, whilst limiting impacts on the environment and promoting a sustainable management of energy and other resources. An academic programme should impart clear awareness of current issues of sustainability and provide basic knowledge of the physical laws needed to comprehend the operation of built environments, together with an understanding of the requirements of their users. Such notions should be delivered in layers, incorporating both qualitative as well as quantitative information, and should be measured against natural processes and contextual conditions (e.g., climate, genius loci, socio-cultural and economic issues, etc.), considering environmental attributes of various built forms and combining the delivery of contents with experiential applications.

**Applications and Case Studies**

The domain of Applications and Case Studies should demonstrate how the principles and objectives of a sustainable environmental approach to architecture and urban design can be translated into practice, and how such process can support the activities and expectations of occupants. The analysis of case studies should include different building types and encompass exempla from contemporary practice as well as from vernacular and historical architecture. Also, it should incorporate at once direct observation, performance verification and post-occupancy evaluation. Coherent comparisons between scenarios can lead to critical understanding, whilst contributing to emphasise possible dissimilarities between the results provided by design predictions and onsite measurements. Presentation of case studies by visiting professionals should be encouraged, so that the illustration of the actual functioning of built spaces can reinforce the acquisition of knowledge and promote a multidisciplinary approach to design. Workshops and seminars should combine both experiential and computational analysis and be followed by experimentation of the tools applied.

**Tools**

The domain of Tools should include generic and specific learning resources to support the exploration of design solutions, simulation/analysis software for calculation and visualisation of energy consumption or prediction of behaviour of built structures, and equipment that quantifies performance of built environments and assesses comfort of users within onsite measurements and analysis. The use of tools is fundamental in order to test, compare and evaluate applications and case studies against measured data and benchmarks, fine tune design proposals and inform decisions, as well as consolidate the acquisition of issues and principles of sustainable environmental design and provide tangible verification to intuitive design solutions.

**STRUCTURE OF THE CURRICULUM**

A plurality of approaches in terms of programme structure can be adopted to deliver and explore this cognitive framework, making it impossible to formulate the ‘ideal’ structure of a curriculum. This, in fact, has to respond to the specific didactic culture, aims, methodologies, resources and organisation of the institution concerned. However, based on an analysis of the correlation between disciplinary domains at various academic institutions - and linking such investigation with the consideration of the contents and the methods for the delivery of knowledge, the pedagogical techniques employed and the criteria utilised for assessment - it is possible to define a series of models of curricular structure that could be considered as paradigmatic for the development of a programme in architecture embracing education for sustainability.
**Paradigmatic Models of Programme Structure**

- **Linear / Parallel**: Each disciplinary domain (e.g., design studio, environmental science, other core and elective modules) runs in parallel and knowledge is delivered autonomously, with ex-cathedra lectures detached from studio and with independent assessment/examination. This ‘satellite’ structure may allow a coherent education on issues of sustainability, although an unclear integration between studio and other coursework could make such principles and values be considered as divorced from design.

- **Partially Integrated**: Taught modules of environmental science/design can potentially represent the link between studio and other core teachings. Although these modules can be taught as stand-alone units, they are generally, at least in part, integrated with other subjects in the delivery or in assessment (e.g., joint submissions and common coursework). This structure allows the introduction of principles of environmental sustainability and their simultaneous creative exploration within design studio projects.

- **Fully Integrated**: Studio modules are conceived as working spaces, where contents of different domains converge around the central role of the design project. Theoretical knowledge of environmental science and other core teachings is delivered in accordance with the requirements, timing and pace of studio, to inform and support the design development. This structure can avoid conflicts between disciplines but requires adequate resources, careful management, cooperation and dialogue amongst staff.

- **Iterative**: Rather than following a linear sequence of knowledge delivery, acquisition and application, this structure is based on a series of interlinked phases, where the contents delivered at one stage inform the competence acquired in the following. At each stage, knowledge is deepened and complexity of exploration grows through a series of cognitive ‘loops’. This model emphasises critical reflection, and is built on a clear dependency between environmental science, design studio and other core modules.

- **Elective / Minor**: This structure is characterised by a number of elective modules - eventually selected from different degrees and/or Departments - that students can include in their study programme as a sequence of domain-specific taught units (e.g., a Minor degree). Delivery and assessment is similar to the Linear/Parallel structure. Such flexibility encourages multi/inter/transdisciplinarity and offers the possibility to investigate sustainability (as well as of other thematic areas) from many different points of view.

Each curricular model has its advantages and constraints, therefore it is necessary that the pedagogy is supported by adequate educational methods and tools so as to facilitate the acquisition and exploration of knowledge, and promote exchanges between different disciplinary domains. Process is important for learning, but the way learning occurs is as important as the content of the learning itself (Orr, 1991).

**METHODS AND TOOLS FOR TEACHING AND LEARNING**

Sustainability has recently shifted from a specialist concern to a position of direct relevance in the agenda of architectural education. This change, however, has not been consistently matched by methods for teaching and learning that fully embed sustainable design at the core of the curriculum. Indeed, sustainability is often viewed as an important addition to a successful design scheme, although not always it is also seen as a necessary and integral component of every subject area of the programme. Achieving a balance poses several challenges, as the implications of education for sustainability in architecture require that this commitment is widely shared by both students and educators, in the lecture theatre as in the design studio.
Lectures and Studio

Architectural education has changed little over the last decades, with most schools still structuring their pedagogy on a curriculum split between theoretical and applied modules. Specialist knowledge is delivered in satellite lectures, where it is assumed that students learn the principles and knowledge that will then, in the studio, guide and inform their design. Gelernter (1988), however, has disproved this sequential approach to education, making the case that such process of knowledge acquisition, recall and application “treats the mind like some kind of simple filing cabinet. The cabinet is empty when a student begins the course, and it is the job of lectures to provide folders [...] and then to place them in the correct sequence in the mental filing cabinet where they can easily be found again. [...] The entire procedure is assumed to happen sequentially: first the folder is introduced, then filled and filed, then retrieved from”. This “assumes the mind works in two quite distinct and sequential modes: first the mind is stocked with general knowledge of potentially universal application, then that knowledge is applied to practical problems”. But “knowledge offered in advance of any attempt to apply it cannot find a conceptual schema in the student’s mind in which to reside, for the required schema can only be developed while struggling with a particular problem” (Gelernter, 1988).

When looking at traditional educational practices, these insights are particularly revealing. Students are often expected to embark on complex studio projects with limited knowledge of the design process itself or the aspired solution. In this way, they can not form even the basis of the conceptual framework (schema) within which knowledge would “reside”. Indeed, when considering that the acquisition and application of knowledge is not a sequential process and that these must be tackled simultaneously, an important observation should be made about the notion of the lecture as a vehicle for providing the skills that inform design. Although apparently delivering the targeted learning outcomes, this pedagogical practice hinders the development of critical thinking, and - in the best of the cases - only favours the mere (albeit often short-lived) acquisition of information as opposed to fostering “deep learning”, where a process of “knowledge construction” converges in a coherent design whole (Warburton, 2003). If the implementation of environmental sustainability in the architectural curriculum requires closer integration between theoretical lectures and creative design studio, then the role, purpose and delivery of the lecture in itself must be examined critically (Cole, 1980).

Traditionally, an education in environmental design has embarked on what is commonly termed ‘left-brained’ thinking. This pedagogical approach, structured on a linear sequence of lectures that take students step-by-step through processes and techniques, aims to develop “good problem solvers through the knowledge of mathematics and physical science” (Kirk and Mulligan 1996). However, this educational method rarely contributes to the development of creativity, imagination, perceptual or spatial skills, and consequently could be deemed unsuitable for a truly integrated - and ‘sustainable’ - design-based programme. Interestingly, studio can be implicated for moving too far in the other direction, fostering solely ‘right-brained’ processes.

This seriously questions conventional architectural pedagogies. If the role of an integrated education is to explore knowledge within the context of its application - where students speculate, investigate and make propositions in a creative and rigorous manner - then the ex-cathedra lecture as a format must move away from this hemisphere-dominated pedagogy. This necessitates a considerable departure from an entirely left-brained, analytic and sequentially objective process to one that embraces right-brain features, encompassing the skills of problem synthesis through creative and critical thinking, intuition and imagination, in a forum that sees both the design studio and the lecture as a place for ‘active learning’. Only through the combination of both hemispheres can the potential of an integrated and sustainable curriculum be realised. To this aim, an attitudinal change on the part of the institution and the staff might need to take place, one that fully endorses and promotes the ethical values of sustainability, and motivates students towards responsible practices.
Ethos and Motivation

The embracement of a positive ethos towards education for sustainability indeed requires effective leadership and the involvement and dedication of all staff. This entails a reflection on the whole curriculum and should be reflected also in the advertisement of the course, which is paramount to attract enthusiastic students and staff that already have an awareness and/or dedication towards sustainability. The knowledge and enthusiasm from the lecturers and tutors can represent key factors in fostering learning of sustainable design, since the attitudes and beliefs they portray may be adopted by their students (Brickhouse, 1990). This is particularly relevant for the staff teaching studio, which can play an essential role to motivate students towards the embracement of sustainability in their coursework and behaviour. Motivation is the major factor that encourages students to learn and change their values (Levy, 1980); students that are motivated want to learn, are more interested and engaged in their learning, and absorb the teaching more readily.

There can obviously be different sources of motivation (Skinner, 1953, 1971). Intrinsic motivation can originate from a challenge, a determination to achieve an objective and/or a fear of failing it. Other sources of intrinsic motivation can include curiosity and involvement in a task. Conversely, extrinsic motivation can derive from the ambition for a reward (e.g., the mark), although receiving appropriate feedback is also a form of extrinsic motivation that is especially effective if it is timely given and if the criticism is constructive. Other significant factors in students’ extrinsic motivation can be represented by group support and peer influence on behaviour and the level of expectation that students have for themselves, and that they perceive the teacher has of them (Child, 2004). In today’s competitive learning environments, extrinsic motivation could sometimes prevail over the intrinsic one (e.g., the experience), even if this latter can surely be more valuable in lifelong learning as it involves a desire to understand rather than simply the ambition to achieve a return (Lepper and Hodell, 1989). There are two techniques that could prove successful to induce intrinsic motivation: applied learning and problem-based learning. Applied learning, also known as ‘learning by doing’, relies on the assumption that students learn when they are interested in the subject, and that learning is more efficient when theoretical and practical knowledge are combined (Levy, 1980). Likewise, in problem-based learning, the motivation provided by the challenge supplies the incentive to learn (Smith, 2009). Other than successfully transferring information, this technique makes the knowledge more memorable - as students have struggled to obtain it - and prepares towards lifelong learning.

Resources for Knowledge Transfer

Amongst the various opportunities to stimulate students’ motivation and engagement - whilst leaving room for reflection and critical understanding - new pedagogical techniques derived from Information and Communication Technologies (ICTs) are rapidly becoming core to many teaching and learning practices. The application of e-learning (e.g., virtual studio environments, shared repositories and databases, wikis, weblogs, e-portfolios, enhanced reality, etc.) in various professional fields indeed offers proof of its ability to ‘activate’ the learning and facilitate synergies between distinct disciplines, skills that are fundamental to the achievement of an integrated design process. ICTs have been recognized as an opportunity to establish new ways for students to learn, work and collaborate with their tutors and peers, locally and globally. These techniques may offer a solution to address some of the dichotomies within the traditional architectural curriculum, providing the potential to fill the gap between creative design and technical sciences, fostering shared learning activities, motivating participants through interactive resources, offering easy and open access to information and facilitating the acquisition of multi/inter/transdisciplinary competence.

E-learning can also present a timely response to the many challenges that higher education is currently facing, such as the need to broaden the geographical boundaries of universities, support continuing professional development, and respond to demands related to financial issues and changes of expectations in the market. However, e-learning should by no means be considered as a substitute for studio and lectures. Yet, by enabling some pedagogical activities to take place outside the physical confines of the academic environment, the effectiveness of the teaching and learning can benefit in increasing engagement of students, disseminating knowledge, encouraging exploration and imaginative insights, improving the richness of design solutions and promoting new methods of personal expression.
The EDUCATE Portal

STRUCTURE AND DEVELOPMENT

The use of e-learning tools is nowadays assuming an increasingly important role in support of pedagogical developments aiming towards the creative exploration of technical knowledge in design. Initial attempts to integrate ICTs in higher education already took place in the early 1950s, although computers in schools of architecture have started to become more familiar only during the 1980s, with the advent of low cost hardware and commercial CAD software, and the diffusion of the World Wide Web (Mizban and Roberts, 2008). To foster the implementation of environmental sustainability and energy efficiency in the pedagogy of architecture and urban design, an intelligent e-learning Portal has been built and tested by the EDUCATE project. The vision for the development of the EDUCATE Portal was to create an online tool that could facilitate the transfer of information, know-how, methodologies and outcomes, provide interactive support to students and practitioners, and reinforce an integrated approach to teaching and learning.

The implementation of the EDUCATE Portal has followed best-practice software development methodology, proceeding in a number of phases in which a series of prototypes have been specified, designed, developed and tested before being deployed to the users. Each phase has consisted of: user needs analysis; functional specification; technical design and specification; technical development/implementation; pilot release and user acceptance; and, ultimately, general release. Such an iterative participatory development process has been essential to ensure user satisfaction and high take-up of the system. Where possible, use has been made of existing software frameworks and components, for example the Drupal (www.drupal.org) content management system. However, no existing system (or combination of systems) could support the various functionalities envisaged for the EDUCATE Portal, and therefore significant development of new bespoke software has been necessary. Given the novelty of the EDUCATE Portal, its structure incorporates significant flexibility, allowing the system configuration to be adapted following the requirements of the users.

The EDUCATE Portal primarily hosts the project’s web page (www.educate-sustainability.eu), where reports, news, data, and information on activities, developments and results of the project are disseminated to target groups (students, academics, professionals and the public). Further to the webpage, the structure of the EDUCATE Portal consists of four main domains - Student Space, Instructor Space, Professional Space, and Public Space - interacting in a Forum and centred around an extensive Knowledge Base.

Diagrammatic Structure of the EDUCATE Portal

6 The report EDUCATE Portal Development and Testing and the source code of the EDUCATE Portal are downloadable from http://www.educate-sustainability.eu/portal-development
7 The EDUCATE online Knowledge Base is freely accessible on https://www.educate-sustainability.eu/kb
DOMAINS AND USERS PROFILES

Student Space

The Student Space includes a number of features, comprised the possibility to interact with peers and tutors. Functionalities fall into various categories: Search the Knowledge Base; Access Reading Lists; Discuss with Tutors and Peers; Ask a Question; Consult Frequently Asked Questions; Upload and Comment on Work.

KNOWLEDGE BASE

The Knowledge Base represents the collected expertise on sustainable environmental design of EDUCATE project partners and is organised in three parts: Issues and Principles, Applications and Case Studies and Tools. Each part is structured in a primary ‘ontology’ - generally subdivided into Directories, Categories and Clusters - which forms a key element of content retrieval. Content in each Cluster is delivered in Topics, Case Studies and Tools and is presented in the form of Tabs, which provide different views on the subject. The Knowledge Base is not limited to a tree structure (i.e., sections and subsections), but rather it offers the possibility to add links between content in different sections and make reference to external resources.

The Issue and Principles part of the Knowledge Base is organised in various Directories, Categories and Clusters. The contents of each Cluster are structured in various Topics, each analysed under the following Tabs: Principles; In Depth; Applications; Teaching Resources; Learning Resources.

<table>
<thead>
<tr>
<th>ISSUES AND PRINCIPLES</th>
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<tr>
<td>DIRECTORIES</td>
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<tr>
<td>1. Global Challenges</td>
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<td>2. Climate, Comfort and Energy</td>
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<td>3. Quality of Life</td>
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<td>4. Impacts and Resources</td>
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<td>5. Architecture and Urban Development</td>
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The Category 'Lighting' in Issues and Principles

The Applications and Case Studies part of the Knowledge Base presents several Categories and two Clusters - Field Studies and Design Projects - applicable to each Category. The Case Studies of each Cluster are analysed under the following Tabs: Project; Layout; Construction; Observations; Performance.

APPLICATIONS AND CASE STUDIES

<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>CLUSTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Culture</td>
<td>a. Field Studies</td>
</tr>
<tr>
<td>2. Education</td>
<td>b. Design projects</td>
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<tr>
<td>3. Urban Development</td>
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<td>4. Residential and Mixed Use</td>
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<td>5. Workplaces</td>
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<td>6. Sport and Leisure</td>
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</table>

Category 'Education' in Applications & Case Studies

Case Study 'Jubilee Campus, University of Nottingham'

The Tools part of the Knowledge Base is structured in various Categories and a general Cluster - Design, Research and Performance Studies - applicable to each Category. The Tools presented in this Cluster are analysed under the following Tabs: Task; Tools; Utilisation; Applications; Resources.
### TOOLS

<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>CLUSTERS</th>
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<tbody>
<tr>
<td>1. Daylighting</td>
<td>a. Design, Research and Performance Studies</td>
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<tr>
<td>2. Space Heating &amp; Cooling</td>
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<td>3. Thermal Comfort</td>
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<td>4. Onsite Measurements</td>
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<td>5. Climate Data</td>
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<td>6. Solar Access and Control</td>
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The EDUCATE Knowledge Base is provided with a searching functionality that allows students and other users to look for specific contents either via a conventional search function, browsing via keyword or performing an advanced search basing on Cluster, Category, and/or Part of the Knowledge Base.

### READING LISTS

Students can be given access to a series of Reading Lists arranged by an instructor at any of the EDUCATE partner organisations, i.e. sections of the Knowledge Base that are particularly relevant to a specific subject area, coursework or design project and which could form part of the background material for a module. Each student is able to visualise all the Reading Lists set up by each of the EDUCATE academic partners, in order to foster exchange of methodologies, pedagogical techniques and contents of teaching.

### DISCUSSION (BLOG)

The Discussion is designed to support interaction between groups of users. These interactions are set to be primarily private to individual groups or modules, e.g., discussions between students, or between students and instructors, although (parts of) other discussions can be made accessible to other users or to the public. Each group of users (e.g., students in a module) can be given access to a number of different Discussions where comments, posts, information, data, links to relevant websites, etc. can be posted and shared.

### ASK A QUESTION

If during the development of a project, students are unable to find a solution to a problem, they are given the possibility of asking a question to an instructor. To allow questions to be directed to the appropriate instructor, each question needs to be tagged by the student with Categories, Clusters and/or Topics from the Knowledge Base, which can be chosen from a drop-down menu. Questions can be free text (typed in a text entry box) and can be accompanied by annotated sketches/images to facilitate the answer.
and the answer may or may not be made visible to other students at the discretion of the instructor. The instructor may decide to make a question and an answer public to all students (and other users) by transferring them to the Frequently Asked Questions (FAQs) section (see below). When asking a question, students by default agree on their question and answer to be published in the FAQ section. Conversely, they are required to untick a box if they do not provide consent for their question to be made public.

FREQUENTLY ASKED QUESTIONS

The Frequently Asked Questions (FAQs) provide answers to the most commonly asked questions on topics, case studies or tools featured in the Knowledge Base. The questions and answers are grouped into the same categories as the Knowledge Base so as to allow users to consult the FAQs per subject of interest.

UPLOAD AND COMMENT ON WORK

This functionality has been designed to support the development and assessment of design studio work. Students enrolled in a specific design studio may be required to upload work for interim or final assessment a number of times during the course of a project. The primary format in which work is uploaded is as pdf files although other file formats are also supported. Each student can create folders containing their uploaded work and organise these into five types: Private, Request for feedback, Group, Submission and Gallery. Folders may be accessible only by the student and the instructor, or by the other members of the student's design studio or group depending on the organisation of the design task. Additionally, a student can mark a folder to indicate a submission for a design task, therefore minimising the need to print out work and submit it to the instructor. If required by the institution and/or the module pedagogy, students may also have access to the work of other students to review it and/or provide comments and peer feedback. The aim of a review is to draw attention to strengths/weaknesses of another student's design by reference to the Knowledge Base. The reviews of other students’ work may form part of the final assessment. The degree of access allowed is configurable to meet the needs of the particular project/group/institution and the stage of the work. Access to uploaded interim work is typically limited to the instructor. Access to finalised work can be wider.

Instructor Space

The Instructor Space has been designed to allow participation and interaction within the EDUCATE Portal to educators (part-time and full-time) at academic organisations. These types of account are generally dedicated to lecturers, studio tutors or other teachers that are able to:

- Visualise and search the Knowledge Base;
- Set up Reading Lists;
- Engage in interactive exchanges with students and other instructors or professionals;
- Manage their design studio (if requested) by visualising the group members;
- Access the work and activities of all the students enrolled in their module or studio;
- Provide feedback to students’ work;
- Review the feedback provided by students to other students’ work (peer-reviewing);
- Assess and provide feedback to Submissions.

Professional Space

Professionals can be given their own personal space on the EDUCATE Portal, where they can access the Knowledge Base and, eventually, a Continuing Professional Development (CPD) area set up in collaboration with the relevant professional body. This CPD area can consist of guided Reading lists through the contents of the Knowledge Base. The Professional Space can also include a dedicated Discussion area, similar to the students’ one. Professionals can also be given access to a list of Frequently Asked Questions, specifically designed for them by an EDUCATE partner institution, and can engage directly with instructors.

Public Space

The Public Space features the contents of the EDUCATE website (www.educate-sustainability.eu), which gives access to publicly accessible reports, news, summaries of events, documents, electronic and printed newsletters, and other project outputs, including a non-editable version of the EDUCATE Knowledge Base.
TESTING OF THE EDUCATE PORTAL

The use of the EDUCATE Portal was tested at partner organisations in two different stages during the second term of the academic year 2010/11 and the first term of the academic year 2011/12. Throughout the testing, users of the EDUCATE Portal (including students, part-time and full-time academic instructors and professionals) have been provided with different functionalities according to the pedagogical practices at their institution. In particular, students were given different account types that allowed them, respectively, to:

- **Type 1**: Search the Knowledge Base; Access Reading Lists.
- **Type 2**: Search the Knowledge Base; Access Reading Lists; Engage in Discussion.
- **Type 3**: Search the Knowledge Base; Access Reading Lists; Engage in Discussion; Ask a Question; Consult Frequently Asked Questions.
- **Type 4**: Search the Knowledge Base; Access Reading Lists; Engage in Discussion; Ask a Question; Consult Frequently Asked Questions; Upload Work; Comment on Another Student’s Work.

The number of users involved in the testing phases has been consistent with current practices of academic teaching in architecture. Throughout the two stages of the analysis, a total of around 2,000 users have been registered with an individual account on the EDUCATE Portal. In addition, considering that around 100 users enrolled on the Portal were part-time studio tutors at partner organisations - each teaching an average of 30 students who were not provided with an individual account - the total number of students indirectly reached within the testing phases of the EDUCATE Portal can be estimated to be in excess of 5,000, therefore being statistically significant to allow an objective evaluation of the results obtained, and measure the success of the EDUCATE Portal in the enhancement of education for sustainable environmental design.

At the end of each testing stage, an electronic survey has been distributed to all EDUCATE Portal users so as to measure its effectiveness in supporting the pedagogy. Out of the 1,973 direct users of the EDUCATE Portal who have been assigned an account and an affiliation, 405 answered the online survey (20.5%). The percentage of responses collected provide a picture that is considered relevant enough to appraise the positive achievements of the EDUCATE Portal in supporting teaching and promoting learning of environmental sustainability in the education and practice of architecture and urban design.

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**Exempla of Consolidated Results from the Online Survey**

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Results of Course and Curriculum Development

TESTING OF PEDAGOGICAL PRACTICES

Following the implementation of the pedagogical principles illustrated in the Framework for Curriculum Development - and the integration of the EDUCATE Portal in teaching and learning - the EDUCATE partners have engaged in a testing phase aimed at evaluating the proposed learning outcomes, cognitive framework, programme structures and educational methods at every level of education and within professional training. Various indicators have been used to appraise the results of the testing, including feedback obtained by students (e.g., Students’ Evaluation of Modules), by tutors, professionals, and evaluation panels (e.g., External Examiners), analysis of marks throughout the year and comparison with previous years of teaching.

The testing has been structured in two stages. Initially, the proposed pedagogical developments have been compared to current educational practices at participating institutions and have been ratified by national professional bodies against their qualification criteria. Subsequently, new and/or adapted course and module syllabi have been developed and compared amongst EDUCATE partners so as to guarantee consistency of targeted learning outcomes. At this stage, a pilot study of 5 months duration has been launched to test the pedagogy devised and measure the integration of the features provided by the EDUCATE Portal. Users of the Portal have been offered various functionalities according to pedagogical practices at each organisation. In collaboration with Chambers of Architects, building professionals have also simultaneously been invited to trial the use of the EDUCATE Portal to support continuing professional development (CPD) activities.

The analysis of the results of the pilot study have lead to further refinement of the pedagogical developments devised by partners, with specific reference to the use of the EDUCATE Portal that, during the second stage of study, the field testing, has continued to enhance exchanges of knowledge, whilst facilitating the review of students’ work and promoting dissemination of best practice of sustainable environmental design. This phase of testing has provided additional information on the development of educational provisions as put in place at partner organisations. Further to this, the field testing has also gathered additional data and information on the effectiveness of the EDUCATE Portal in supporting the integration of environmental sustainability and energy efficiency in academic and professional education.

Simultaneously to the field testing, an International Student Award under the banner of EDUCATE Prize was launched, to which staff and students from departments, schools and faculties of architecture or cognate disciplines worldwide have been invited to participate. The EDUCATE Prize was intended primarily as a vehicle of dissemination of the outcomes of the project, particularly considering that academic staff and students registering to the Prize were given immediate secure access to the online Knowledge Base. In addition, the EDUCATE Prize has offered the opportunity to appraise pedagogical methods and results of teaching and learning of sustainable environmental design and energy efficiency under a global perspective.

Amongst the organisation and results of new/revised module syllabi and briefs developed by EDUCATE partners within the testing, of particular interest to the purpose of curriculum development are the following:

Undergraduate Level

Environmental Science for Architects 1 - University of Nottingham

This year-long module is delivered in the 1st year of the architectural and engineering curriculum and introduces students to the environmental agenda as it applies to the architectural profession. The module is fully delivered ex-cathedra - being characterised by a high staff-to-student ratio (3 staff members for around 200 students) - and is part of a parallel/partially integrated curricular structure. It encourages consideration of environmental issues from the outset of a project and explores rigorously the key bioclimatic strategies used to maintain appropriate conditions for the occupants of built spaces, tying together occupant comfort, building programme and climate. The module also introduces students to simple analytical tools and

9 For a comprehensive illustration of the briefs of the modules developed or revised by EDUCATE project partners within the testing (in English and in original language) and a detailed breakdown of the results, please see the report Results of Course and Curriculum Development available on http://www.educate-sustainability.eu/results-of-development

Education for Sustainable Environmental Design
EDUCATE

Results of Course and Curriculum Development

techniques to explore and understand the proposed environmental strategies within their design projects. The pedagogical method is centred on a learning by doing approach, where notions and principles are presented simultaneously with their application in practical exercises. In the first semester, lectures focus on the framework of sustainability in the context of architectural design and introduce issues of environmental psychology and thermal, acoustic and visual comfort. The second semester is devoted to the exploration and application of daylighting in built spaces. The delivery and acquisition of knowledge is supported by a series of group projects and a final individual assignment. Initially, students engage with the MovieSTAR project, where groups of 3-4 students are asked to produce a short movie exploring the complex meanings of sustainability in its various dimensions. In the second semester, groups of 3-4 students complete two assignments: the Sunrose project asks students to build 3 sunroses (a 3-dimensional version of the sunpath) for Nottingham and 3 sunroses for another location of their choice, analysing and comparing solar geometry and characteristics of climate; the Daylight Filter project asks students to explore a technique for modifying flows of light and then design, build and test a small test sample that demonstrates their concept and the obtained light/shadow effects. The module is concluded by an individual assignment, Daylight Design, where students, basing on their current design for the studio project, are asked to produce an individual 10x A3-pages report exploring how sunlight and daylight influence the creation of their designed spaces, providing evidence of their proposed strategy via calculations (e.g., shading devices, shadow masks, average daylight factor), direct measurements (e.g., artificial sky) and rigorous testing (e.g., heliodon).
project. The list of contents of the syllabus are explained in a systematic and ordered way. Lectures are organised to encourage interactions between the students and the tutor. Students work individually or in groups on projects and essays focused on the main topics presented by the programme. Tutorials are conceived to guide students on aspects such as conceptual organization, development of contents, resources, graphic expression, formal conception and conclusions. Several teaching communication tools are promoted, such as oral presentations, discussions, recommended readings, criticism sessions, development of questionnaires, seminars, etc. The module also requires a test to assess the ability of critical thinking and contextual relationship of students in relation to the contents and competences of the module. The project that students are asked to develop should be based on a relational and reflective approach, and show a good management of resources. Students are encouraged to attend various activities from different areas of culture that can be part of their integral training as students of architecture, such as exhibitions, artistic performances, book presentations, and conferences. Students are also introduced to the methods of research as a key activity, so as to establish the basis of a research-based approach to architectural composition to be further developed at the following stages of their education.

Workshop I - University of Seville

The main objective of this design studio, offered in the 2nd year of the curriculum, is the simultaneous and comprehensive integration of competences that students acquire during their learning process through the development of a relevant architectural design proposition supported by a group of tutors from different Departments. The project deals with the concept of habitation and introduces students to the multidisciplinary reality of the architectural work. For that, the concepts of social cost and environmental adaptation are taken into account, developing critical capacity and ethical commitment to society and to current living conditions. The work is carried out in a cyclical rather than in a linear way, synchronizing the processes of formal and spatial configuration with the design of the structural system at a schematic level. At the same time, students discover and work with all kind of materials and product families, enhancing their suitability from the analytical phase, in order to adapt their design proposal to the contextual conditions. Passive environmental strategies to improve comfort and living conditions for the occupants need to be considered according to their effect on the energy balance and environmental impact, and have to be based on simulated or calculated models to verify the results of the design proposals developed. Simultaneously to the lectures, teaching projects groups can organize tutorial sessions to deal with the problems that students find in developing their design progress and can also organise visits to the site of the project or to other buildings relevant to the students’ design development. The final presentation is held at the presence of all the teaching staff and is open to all students of the workshop.

Architecture, Technology and Sustainable Development Studio - Catholic University of Louvain

The aim of this 3rd year design studio is to, qualitatively, address themes of sustainable architecture such as energy conservation, use of environmentally friendly resources, management of water, mixed programmes, mobility, etc., and, quantitatively, to integrate in the architectural design project the basic physical concepts that allow control of the atmosphere/ambience of spaces and visual/lighting comfort. Both direct measurements and computer simulation are used to gain a better understanding of the strategies involved and their relationship with building design. The design studio concentrates on empirically illustrating how natural light can support architectural design in terms of composition of spaces, whilst also providing rigour in design development. Yet, although the focus is mainly on the study of natural light and its impact on spaces and atmospheres, students must have a comprehensive approach to sustainable architecture. The design development, finalised at the presentation of a proposal for a library building in an inner city location, includes a significant assessment phase in the laboratory. Theoretical data are introduced at an early stage of development, explaining techniques related to sustainable architecture, the use of daylight simulation tools such as the VELUX Daylight Visualizer software, the construction of physical models for laboratory study, and the analysis of methodologies for direct measurement under an artificial sun and sky. The progresses and results of the students’ work are presented twice, during a pre-Jury critique where the lighting and sustainability aspects are reviewed, and at a final Jury that concludes the studio. The project and laboratory evaluation is conducted in groups of two students. Each student is asked to present, together with the final design, a report explaining the design development, the simulations undertaken, and the results obtained.
Graduate Level

Technology and Building Physics Studio - University of Rome La Sapienza

The module, taught at the 4th year of the architectural curriculum, aims to provide students with the technological and environmental knowledge needed to control architectural design, and the construction and management processes. The programme highlights the relationship between an environmental approach to the project, technical choices and the expressive purpose of architecture, through the study and application of methods, tools and techniques of "integrated design", intended as an organic design process capable of handling the many specialisms involved in contemporary design. Students develop the design of a small dismountable pavilion able to perform the function of social aggregation point in a flexible and adaptable way, so as to meet the practical needs of the context in which it is placed and, at the same time, be relocated in contexts with characteristics - partially or totally - different from the original one. The temporary pavilion must be an exemplar of sustainable design in its conception and its operation, utilizing local materials, manufacturers, suppliers and labour where possible. It should also be energy self-sufficient and provide energy to the surroundings areas, focusing on renewable energy production through solar and photovoltaic systems. The module is conceived as an interdisciplinary working space, where the specific contents are delivered according to a cyclical and progressive syllabus in which lectures ex-cathedra provide knowledge to meet the demands of studio. The theoretical contents, notions and principles converge within students' design projects basing on a problem-based learning approach, which engages students with specific problems, increases their interest levels in the subject and makes the knowledge more memorable. The module includes interim reviews arranged once a week and a series of deadlines in which students discuss their work at a common critique. The lectures ex-cathedra deal with environmental design factors in the design of temporary architectures, theories and principles of sustainable development, innovation and technology transfer, life cycle assessment, simulation techniques, hybrid technologies, low-impact materials, building physics and energy efficiency. The associated modules of "Building Physics" and "Automated
Design* - part of a *partially integrated* structure - contribute to the development of the project in terms of “integrated design” criteria, finalising their contribution to the verification of system solutions in relation to the environmental comfort, and to the design control through methods and techniques of representation.

**Extracts from Students’ Final Designs**

**Technical Immersion of Design Studio - Technical University of Munich**

Alongside the main design studio project, each student has to undertake an integrated design studio module, Technical Immersion, during the last two years of their architectural education. This design development must be carried out in collaboration with one of the Chairs of the Faculty of Architecture. Students can opt to take this module in collaboration with the ClimaDesign programme, Chair for Building Climatology and Building Services. ClimaDesign presents solutions for buildings that can achieve more while needing less technology. Its aim is to develop buildings that offer maximum comfort while using a minimum amount of energy. An integrated approach towards the building and urban design process is emphasised within the programme. Architecture and technology should not be considered in a serial manner, but rather they must form a balanced and concerted system, holistically conceived within a multidimensional design process. Such design approach not only embraces the form and geometry of the building, but also needs to take into account further parameters such as passive building and urban design, temperature, energy supply systems in buildings and urban structures, materials and water use and re-use, economical aspects, and, of course, human/user needs and comfort requirements. The skills required of students, therefore, include backing up design ideas with energy, comfort, daylight and economic calculations. This is normally done by intuition based on experience of design and the systematic analysis of completed buildings, supported by the targeted use of design and computational tools. This module ultimately aims to give to students a multidisciplinary awareness of the numerous environmental factors relevant to architectural and urban design and preservation that are involved in the design development process, including the needs of the occupants, building programme and building and urban climatology. Knowledge transfer in practice is encouraged and plays an essential part of the pedagogical method promoted by the module through consultation of publications, guest tutoring and critiques, attendance at exhibitions, conferences, etc.
Diploma Design Thesis - University of Nottingham

This year-long module allows students to identify and explore a topic of interest related to architecture and to develop a design thesis based on research carried out throughout their final year of graduate study (6th year). Students are expected to plan and execute a programme of independent study and, with tutorial advice, to initiate, develop and execute a design thesis with an appropriate theme. The programme provides the opportunity for students to explore and research in depth those aspects of architecture that are of particular interest to them and declare their intellectual and design position. The module is strictly interrelated with the design and research activities carried out in the context of a Design Research Studio that students can join. The Design Research Studios are organised as collaborative groupings managed by a Studio Leader and a number of associated tutors that provide continuous support on the theoretical, design and technical (environmental and structural/construction) aspects of the design development. The Design Thesis allows the development of the core skills expected of an architecture student at the final stage of their learning, as well as providing the opportunity for them to explore and research in greater depth particular aspects of architecture that are of special interest to them. Students are expected to exercise initiative and personal responsibility and continue to advance knowledge and understanding of architecture through an independent and research-led attitude to learning. The programme of the module is organised in monthly common reviews where students from all the Design Research Studios come together as a group to present and discuss critically their individual design development at the presence of mixed panels made up of tutors from different Studios and external guests. The module aims primarily to support students in articulating a philosophical approach that reveals an understanding of theory in a cultural context, and generate and systematically test, analyse and appraise design options that display methodological and theoretical rigour. As part of the requirements for the Diploma Design Thesis, students need to show evidence of having critically appraised and formed considered judgements about the spatial, aesthetic, technical and social qualities of a design within the scale and scope of a wider environment, and demonstrate knowledge and understanding of building technologies, environmental design, structural theories, construction techniques and processes, and the provision of building services within the framework of the physical properties of building materials and components, and the environmental impact of specification choices.
Complex Design Studio 1 and 2 - Budapest University of Technology and Economics

This module runs for the entire final year of the architecture programme and is composed of two stages, Complex Design Studio 1 and 2. The target of this module is for students to practically apply their theoretical knowledge and experience the working methodology of a complex design process through the creation of a contemporary building inspired by a sustainable ethos. The students work individually and the design is developed both in drawings and written specification documents conducted under the supervision of architectural consultants and other tutors from the associated teaching Departments. The design must be verified from the point of view of structural engineering, construction technology, mechanical engineering and environmental engineering solutions. To get from the initial idea to the final design, the project and all its technical details are developed by analysing their complex interactions. The requirements of a sustainable approach to design demand research work from the part of the students, so as to generate new and innovative solutions. Following a site visit, the first semester starts with introductory lectures to prepare the students for their design task. During the module, the students have to give three presentations of their preliminary design project in front of the tutors. Once the initial concept is accepted, the students prepare drawings of their design up to a planning permission level, including the required schemes in the fields of structural and HVAC engineering, building construction and the organization of the construction works. In the second semester, the module focuses on the development of the previous project. The students choose an area of their building to design at a much more detailed level. After presenting the draft project in the studio, the students develop their buildings to a stage that could be used as a production information document: plans and sections, accompanied by detailed drawings regarding interior design and landscape elements, completed by an environmental impact study. In each semester, the students need to take two 1-day long design tests, which consist in the preliminary design of a small sized building developed individually without the help of their tutors. These tests are conceived similarly to architectural competitions and their purpose is twofold: to foster independent work and to develop creativity. The projects are evaluated at a final review at the presence of all students and tutors.

Postgraduate Level

Project I: Urban Case Studies - Architectural Association School of Architecture

This module of the MSc/MArch in Sustainable Environmental Design is the main vehicle for the application of the theoretical concepts and computational tools introduced by the taught programme in the first term of the academic year. The project involves fieldwork including measurements of environmental conditions and extensive analytic work using dynamic thermal modelling and solar, airflow and daylight simulation studies. It is undertaken in teams of four students, with each team focusing their project work on an existing residential or mixed-use development. The students’ teams are expected to look at how different microclimates form in cities and the effects these have on activity and environmental quality in and around buildings. The project combines mapping of activities in selected buildings and outdoor spaces with environmental measurements across sections of the city. These offer information on the nature of environmental conditions, as well as providing numerical data with which to calibrate computational tools that are then applied to perform parametric studies as part of the design research. The findings of these studies provide starting points for the design projects that follow in the second term, exploring adaptive and performative strategies that can achieve autonomy from conventional energy sources addressing climate change and environmental quality. Weekly lectures and workshops introduce students to the concepts and analytic tools that are to be applied on the project. Tools include scientific instruments for measurements as well as survey techniques and software for environmental simulation. The sequence of project tasks follows that of the topics covered by the formal teaching with a little time lag, so that students have time to practice the use of new techniques on small exercises before applying them on the project tasks. Team work is an essential component of project work and provides an additional source of learning. Studying how buildings work in practice gives an excellent vehicle for learning the principles and tools of sustainable environmental design. The findings of the fieldwork and simulation studies provide a diagnostic assessment of existing urban schemes, as well as highlighting potential for environmental improvements. The main outcomes accomplished by the Project I are: the undertaking of fieldwork involving the study of the urban fabric and that of buildings; interviews with inhabitants, with designers and site managers; measurements of key environmental variables; processing of
fieldwork data; computer modelling and environmental performance studies; review of published sources and improvement proposals for the selected sites; comparison of findings from individual studies within the team, with the findings of other project teams and also with published benchmarks; the drawing of main lessons from the selected case study; reporting on progress in weekly tutorials and presenting regularly in class; writing, revising and illustrating the Project's submission documents.

Excerpts from Students' Projects

Dissertation Project - Architectural Association School of Architecture

The Dissertation Project is the final and most substantial piece of work for the MSc and MArch in Sustainable Environmental Design. It represents a significant piece of individual work that reflects the programme's areas of research and the students’ personal interests, background, special skills and plans for the future. For the MSc, the Dissertation Project combines critical investigation of a research topic with the help of case studies and analytic work aiming at better understanding the underlying design principles and practical applications in a given context. For the MArch, the research must culminate in an original design application that must be developed in some detail. Submission is in the form of a bound thesis document of some 15,000 words. Project development is studio-based and is supervised on a weekly basis by tutors and consultants assigned to the students. Class presentations are held at regular intervals to obtain feedback from invited reviewers. In
the first stage (Phase I) of the Masters programme, project briefs, contexts and methods of work are predetermined as part of the student’s learning by research process. The Dissertation Project (Phase II) is a test of what each individual has learnt, and how the knowledge and understanding acquired are applied to the formulation and investigation of an approved research project that represents 50% of the credit units for the Masters degree. The collaborative ways of team project work of the first two terms can be continued into Phase II, if the students find such collaboration productive. However, the emphasis in this Phase is placed on individual initiative, judgment and output. The main outcomes of the Dissertation Project are: the formulation of the project’s research topics; a critical review of relevant literature on the chosen subject area; study of built precedents; undertaking of fieldwork where appropriate; computer modelling and performing of simulation studies to compare and assess the effect of different parameters on environmental performance; reporting on progress in weekly tutorials and regular class presentations; writing, revising and illustrating the Dissertation Project’s submission documents.
CRITICAL ANALYSIS OF RESULTS

The results of the testing have revealed that at the first level of the curriculum, when students explore and form their architectural position, they generally demonstrate a positive attitude towards sustainability in their evolving design language. However, students at times start their education with some misconceptions and biased opinions on the framework of sustainability. Energy reduction, climate change, waste disposal, recycling, etc. are seen as topics relevant to current building practices but still relatively devoid of inspiring architectural design implications. For this reason, a transmissive model of education - typical of many ex-cathedra lecture-based courses - may not be appropriate to guarantee the achievement of an in-depth exploration of environmental sustainability and its significance in design. Rather, a pedagogy based on learning by doing can enthuse and foster interest for a sustainable design approach and explore the creative inspiration it can bring to architectural projects. Students need to develop awareness and understanding of problems and notions of sustainability by their direct experience with them. Lectures should not be presented independently of studio, but rather they should link theoretical principles with applications, continuously showing precedents and exempla of previous work so as to allow students to take ownership of their own learning and make the concepts acquired easily transferable to other coursework. Time is also a key factor; students need to be given the opportunity to think back and reflect on their educational development.

At the second level of the curriculum, students have likely already been introduced to - and explored - issues of sustainable environmental design and, in some circumstances, they may have previously engaged with periods of professional practice. In this case, therefore, a pedagogy that enhances motivation towards environmental sustainability is of paramount importance, and this should be preferably based on an educational approach founded on problem-based learning. The teaching should be supported by tangible paradigms of best practice. Students need to be shown exempla of built spaces, obtain evidence of reliable performance data, and need to be able to see the opportunities inherent in sustainability. Consultants, practicing architects, engineers, part-time specialists, etc., should thus be involved in the pedagogy, and, to that extent, the allocation of adequate resources and a full support from the academic institution is key. This would help to promote a design culture informed by sustainability, and reinforce the incentive towards the teaching and learning of sustainable environmental design.

At the third level of the curriculum, students are generally highly motivated and already knowledgeable about the discipline of sustainable environmental design, particularly in the context of targeted post-professional courses. Tools provided in support of the pedagogy need to be accurate and reliable, with external resources systematically listed and with the provision of scientific data to be explored for the comprehensive investigation and understanding of built case studies. The role of research as an investigation and educational medium should be highlighted, in the context of a pedagogical approach which should be based on performance-based learning and design research. Where relevant, advanced tools for simulation, analysis and verification of performance data should be offered, so as to allow students to embark on a journey of discovery that can potentially open new avenues of scholarly or practice-based research, as well as the development of innovative products and/or designs.

Finally, in terms of engagement of practitioners in continuing professional development - and their close interaction with academic teaching and learning and research activities - a long-term vision and the promotion of opportunities to foster sustainable design practices by regulatory bodies should be advocated. This should be supported by the implementation of appropriate educational and professional frameworks that create real drivers and demands for sustainability, beyond the unique meeting of carbon-reduction targets.
The EDUCATE Prize International Student Award

The EDUCATE Prize is an international award that was launched by the EDUCATE project to celebrate outstanding student work that creatively investigates and reflects on the various dimensions of sustainability in architecture and urban design. The Prize also aimed to reward original and innovative ideas and pedagogical methods promoting sustainable principles and practices in curricula of higher education.

Academic members of staff from Faculties, Schools and Departments of Architecture (or related discipline) worldwide were eligible to register their module, course or design studio unit to the EDUCATE Prize, and submit maximum one student work under each of the following three Categories:

- **Category 1: Student Design Projects** (Years of study 1-3, Undergraduate Degrees)
  
  Category 1 was set to reward design projects developed in studio modules at the first level (e.g., Bachelor degrees) of higher education. Design entries had to deal with the field of architecture, urban design and/or planning or building renovation.

- **Category 2: Student Design Projects** (Years of study 4-7, Graduate/Postgraduate Degrees)
  
  Category 2 was set to reward design projects developed in studio modules at the second and third level (e.g., Diploma and/or Master degrees) of higher education. Design entries had to deal with the field of architecture, urban design and/or planning or building renovation.

- **Category 3: Open Student Work** (All years of the curriculum)
  
  Category 3 was set to reward all non-building design projects, including (but not limited to) short essays, videos, artwork, etc., dealing with themes of sustainability in architecture, urban design and/or planning or building renovation in an original and innovative way.

The Jury of the EDUCATE Prize was composed by representatives of Chambers of Architects, including:

- RIBA - Royal Institute of British Architects (United Kingdom): Richard Hawkes
- Conseil National de l’Ordre des Architectes de Belgique (Belgium): Richard Delviesmaison
- Bayerische Architektenkammer (Germany): Oliver Heiss (Chair of the Jury)
- Ordine degli Architetti, Pianificatori, Paesaggisti e Conservatori di Roma e Provincia (Italy): Patrizia Colletta
- Consejo Superior de Colegios de Arquitectos de Espana (Spain): Nieves Mestre, Eduardo Roig
- Magyar Epitesz Kamara (Hungary): Attila Ertsey, Jolan Racz

International Architects have also contributed to the assessment of the EDUCATE Prize, including:

- Peter Clegg - Feilden Clegg Bradley Studios (United Kingdom)
- Mario Cucinella - MCA Architects (Italy)
- Bill Gething - Bill Gething: Sustainability + Architecture (United Kingdom)

Academics registering to the EDUCATE Prize were provided with free access for themselves and their students to the online EDUCATE Knowledge Base. The brief was left entirely open, so as to reflect the flexibility, autonomy, individuality, cultural diversity and innovation of approaches that characterise contemporary architectural education. Assessment criteria were primarily based on the technical and theoretical contents of the Knowledge Base. However, the pedagogical methodologies for supporting the design development utilised by the academic members of staff, teaching and learning processes, capacity of critical reflection and awareness of sustainable mandates have also been considered by the Jury.

A total of 122 academics registered to the EDUCATE Prize in representation of 25 countries and 64 Universities worldwide (48 Universities from Europe, 6 from North America, 5 from Asia, 2 from South America, 2 from Australia, 1 from Africa). By the set deadline for submission (9th December 2011), 86 entries were received from 42 Universities (34 Universities from Europe, 2 from United States, 2 from Chile, 1 from Canada, 1 from Bangladesh, 1 from Singapore, 1 from Malaysia).
FINAL RESULTS

CATEGORY 1

1st Prize (ex-aequo) - The Concrete Orchard & Copra Production Facility

Author: Jacob Szikora; Tutor: Gabriel Tang, Sheffield Hallam University, United Kingdom

Comments of the Jury: The project deals with the issue of food supply in urban centres, intending to promote the use of vegetable crops such as the coconut palm via the reintroduction of 'Nose to Tail' consumption patterns. The project is a Platform for Growth, a greenhouse structure entirely wrapped in ETFE. The design aims to reach beyond the limits of the site by encouraging those without gardens to grow crops, wherever space permits. The Platform aims to produce, process, package and sell its produce entirely on site.

Extract from the entry The Concrete Orchard & Copra Production Facility

1st Prize (ex-aequo) - Hanging Hive

Author: Farhad Malek; Tutors: Gladys Masey, Clare Wrigley, Charlie Smith, Liverpool John Moores University, United Kingdom

Comments of the Jury: From the philosophical point of view, the project makes clear that without pollination, the population will starve. Commonly, architectural projects celebrate man’s glory; conversely, in this project, a building is designed entirely to the glory of a very small insect. From the ecological point of view, the project makes the important statement that the protection of bees is a warranty for our future. This project’s quality is based on both an ecological and educational vision, with the proposal of a remarkable strategy for local energy production and the management of solar energy.

Extract from the entry Hanging Hive
Honorary Mention - RAWlab

Author: Francis Hunt; Tutor: Maria Kessler, Oxford Brookes University, United Kingdom

Comments of the Jury: The objective of the proposal consists in underlining the social aspect of architecture, presenting a visionary point of view with respect to contemporary challenges. The project explores the consequences of the selection of building materials, taking into account the ‘butterfly effect’ in a globalised world. The re-use of city waste within a reversible process is implemented in the design of this super-structure whose main aim is to define a new sustainable paradigm in the use of resources.

Extract from the entry RAWlab

Honorary Mention - SOsMALIA

Authors: Iván Hernández Acosta, Mónica Sánchez Rivero, Raquel Jara Sánchez Zarzuela, Aníbal Jiménez Fernández; Tutor: Lino Alvarez-Reguillo, University of Seville, Spain

Comments of the Jury: This proposal has a very strong sense of place and has successfully understood the culture and social context of the chosen setting. The program is humble and practical, and responds to the existing needs of its location. The project investigates the materials for construction and implements them with sound and practical strategies. The low tech nature of the proposal, and its reference to existing social and cultural patterns, is delightfully sustainable in its ambition.

Figure 4. Extract from the entry SOsMALIA
Honorary Mention - The Mother

**Author:** James Eyres; **Tutors:** Elena Marco and Paul Kirby, University of West of England, United Kingdom

**Comments of the Jury:** The project deals with the issue of food production in the urban habitat. The brief of the project is well articulated in order to provide entertainment while accomplishing social issues. In fact, as in a public garden, the community takes care of the production of crops as if they were in their own backyard. In the end, a well integrated architectural solution is to be highlighted as the result of the design process. The proposal is well developed and successfully harmonized within its environment.

*Extract from the entry The Mother*

**CATEGORY 2**

1st Prize - The Ark - Continuous Productive Urban Landscape Market

**Author:** Stavros Zachariades; **Tutor:** Alex Wright, University of Bath, United Kingdom

**Comments of the Jury:** The project aims to create a strong sense of street life along the North Western edge of the site, integrating a wide variety of activities. The programme organizes functions in a strategic way, cleverly creating a dialogue between the urban street and the agricultural domain. The design quality, presentation and thinking process is elegant and strong. The rational use of modular components to create a flexible infrastructure is coherently developed and it is integrated within a bold design proposal. The concept of local people growing and selling products in one place is convincing and clearly serves a local desire. Technology has been integrated to enhance the lives of the people and the function of the building. Yet, technology is not used for its own sake but for the processes undertaken in the building by the users.

*Extract from the entry The Ark - Continuous Productive Urban Landscape Market*
2nd Prize - PLA:/LIVE Project

Author: Andrew Edwards; Tutor: Maria Kessler, Oxford Brookes University, United Kingdom

Comments of the Jury: In this project, the designer abandons his traditional role of leader of the process in order to become a real partner of the people and fulfill the dream of a collective garden. The basic philosophy developed in the proposal is the realisation of an idea shared by all the participants (users and designer). This is comparable to the medieval gardens realized by a community for the benefit of all. The project investigates the issues of sustainable design from a social, economical and environmental point of view.

Extract from the entry PLA:/LIVE Project

3rd Prize - Sustain Up-Building India

Authors: Alejandro Pacheco Diéguez, Dacil Lorente, Diego Peña, Virginia Ruiz Campos, Nieves Sánchez Alfonso, Rafael Ramirez Álvarez de Lara, Niccoló Navarro Di Meo, Pedro Trujillo Fernandez, Manuel Gómez Pérez, Manuel Valenzuela Salamanca; Tutor: Antonio Garcia Martinez, University of Seville, Spain

Comments of the Jury: The project deals with social, economic and environmental sustainability of building systems in a context that drives students to go beyond conventional construction processes. The project applies passive design strategies, local materials, rain water and organic waste recycling. Social sustainability is addressed as well by means of design quality. The design of the single unit is based on an analysis of local housing characteristics in terms of size and cultural and social habits. Housing modules are designed for family clusters of 5-6 members, providing the opportunity of combining several clusters, according to the circumstances of each family. Ground floor spaces are dedicated to animals and crops.

Extract from the entry Sustain Up-Building India
CATEGORY 3

1st Prize (ex-aequo) - Landscape Interpretations / Ecological Explorations

Authors: Jacob Rathbone, Melody Blundy, Rosie O’Neill, Matthew Beaumont, Jessica Wallis; Tutor: Nicole Porter, University of Nottingham, United Kingdom

Comments of the Jury: Students explored the question of designing sustainably in a sensitive ecosystem, a picturesque landscape, a historic industrial artefact, a home for thousands of people and a tourist destination for millions, by creating on-site artworks which address the complex cultural, economic and social qualities of the landscape. Underpinning the process is the notion that sustainable design must be grounded in a holistic understanding of landscape, this demanding a creative/intuitive and technical/informed engagement.

Extract from the entry Landscape Interpretations / Ecological Explorations

1st Prize (ex-aequo) - Low Cost Alternative Sustainable Systems

Authors: D. Toyans, L. Alvarez, J. Coleman, G. Aguilar, H. Daneshman, I. Magiati, H. Lee, A. Pollancic, B. Yeh, B. Handa, T. Hakopian, R. Higa, A. Magrina, C. Kourafas, C. Young, C. Wong, D. Tolios, B. Ro, A. Goldberg, K. Redman, M. Richeson, A. Marino, E. Christie; Tutor: Pablo La Roche, California State Polytechnic University Pomona, United States of America

Comments of the Jury: The project presents the development of alternative low cost passive and active systems that can be used to improve building performance, while contributing to develop a contemporary architecture that maintains traditional values and is respectful of its environment. The project is the result of a seminar-based course developed in collaboration with NGOs doing work in disadvantaged communities. The project develops an idea through the design, construction and testing of building components and systems.

Extract from the entry Low Cost Alternative Sustainable Systems
1st Prize (ex-aequo) - The passive cooling system from tradition to innovation: Wind Towers

Author: Golnaz Ighany; Tutor: Maria Luisa Germana', University of Palermo, Italy

Comments of the Jury: The work is a scheme that shows a synthesis of a PhD research, exploring the potential use of passive cooling systems and natural ventilation with specific reference to wind towers in the Middle East and Mediterranean areas. The most common types of wind towers are analyzed in relation to different aspects: from the typology analysis to the dimensional one; from materials to systems and construction processes; from ‘live welfare’ to energy efficiency. In parallel, an analysis is conducted on modern passive cooling systems to produce a methodological document that could be useful to designers for the choice of technological solutions towards energy efficiency.

Extract from the entry The passive cooling system from tradition to innovation: Wind Towers

1st Prize (ex-aequo) - MovieSTAR (Sustainable Thinking in Architecture)

Authors: David Edward, Elliott Denham, Neeraj Chandi; Tutors: Sergio Altomonte and Peter Rutherford, University of Nottingham, United Kingdom

Comments of the Jury: This enjoyable project was set up for 1st year students to explore and reflect on the sustainability agenda in all its complex environmental, social and economic dimensions. Students were requested to produce a short movie creatively exploring, analysing and discussing on the principles and values of sustainability and reflecting on how, according to them, such agenda can inform, influence and drive the design of the built environment at a local (as well as global) scale.

Extract from the entry MovieSTAR (Sustainable Thinking in Architecture)
Sustainable Architectural Education

THE CHALLENGE OF EDUCATION FOR SUSTAINABILITY

Education for sustainability is an emerging paradigm that transcends disciplinary boundaries, wielding a potentially profound, but also imprecisely understood, influence that requires a reflection on the way in which new generations of students and practitioners are trained within academic and professional institutions. If the sustainability agenda now looms large, the central concept is, however, inherently elusive and largely defies consensus beyond a relatively shallow one. This inherent lack of conceptual clarity is further exposed within the realm of education, and there is a danger that what emerges is essentially a superficial consensus predicated upon the potentially prescriptive aims of education for sustainability. Scholarly perceptions of the pedagogical impact of sustainability are complex and not necessarily complementary. Based upon research in the specific domain of architectural education, sustainability surely represents a social change agenda informed by an understanding that technological solutions cannot hope to single-handedly eliminate the need for a fundamental revision of ethics - from the institutional to the personal level - and the values and motivation of all parties involved in the educational process. Such an investigation necessitates asking broader questions of how and why students learn. Approaching sustainability in a non-prescriptive manner should be deemed a pedagogical imperative. The challenge is to be found not so much in an illusory pursuit of agreement upon precise goals, but in the ability to appreciate situation-specific contexts and embrace multiple interpretations of a sustainable approach to design, informed by place and a sense of history.

Sustainability should be integral to architectural design and education. Buildings and urban spaces significantly influence the way of living and thinking of their users. As a result, academics and students are confronted with the significant challenge of negotiating a clear path that embraces robust, pluralist, contextually-sensitive conceptions of sustainability. However, academics frequently discover how difficult it is to incentivise or motivate students to apply knowledge and principles pertaining to sustainability in their design work. It also seems clear that any ambition to promote commitment to questions of education for sustainability is confronted by appreciable and multi-layered pedagogical challenges. Educators face the demanding task of trying to understand the complexities of students’ engagement and negotiate with its multiple dimensions. Conversely, logistical factors and attitudinal approaches also impact upon effective teaching and learning for, and of, sustainability. Indeed, it may be argued that both educators and students often, for different reasons, fail to depart from purely transmissive learning models, where theoretical knowledge is delivered (and acquired) independently from its practical application and creative exploration. Education for sustainability raises profound questions concerning how knowledge is acquired and applied and the limits to discipline-based pedagogies. Deep engagement with learning should be achieved by anchoring the acquisition of principles and values with experience, and establishing a unifying framework that permits effective dialogue across disciplinary domains. Enquiry and discussion should be fostered by the pedagogy, so that connections between key concepts can be made. A meaningful education for sustainability should entice students to take control over the processes of problem-solving and evaluating their progress. At the broader curriculum level, therefore, educating for sustainability should be best tackled within a more fully integrated pedagogical framework in which traditional disciplinary ‘silos’ are purposely transcended. It is certainly conceivable, and to be hoped, that the complexities attending sustainability and the pursuit of greater multi/inter/transdisciplinarity can offer rich and inspiring pedagogical opportunities.

In conclusion, education for sustainability faces stiff and diverse challenges, many, doubtless, of a general and generic nature, relating to such matters as resources, expertise and commitment. Other challenges relate more to how the sustainability agenda can impact upon particular institutional contexts and how sustainability is understood, interpreted and applied according to individual pedagogies, framed - as it should be - by subject benchmarks, and national and international regulatory frameworks. Nevertheless, the various ambiguities and inconsistencies associated with education for sustainability need not be solely considered as a source of weakness, but rather as opportunities to analyse and negotiate competing knowledge claims, from different disciplines, and thereby stimulate investigative thinking and effective learning experiences.

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10 The white paper Sustainable Architectural Education is available on http://www.educate-sustainability.eu/white-papers
AGENDA FOR SUSTAINABLE ARCHITECTURAL EDUCATION

Architectural curricula should foster knowledge, skills and competence in sustainable environmental design, aiming to achieve comfort, delight, well-being and energy efficiency in new and existing buildings, and in urban spaces. This should be promoted within a culturally, economically, and socially viable design process at all stages of the education of building practitioners, by adoption of the following principles:

1. Sustainable environmental design should be seen as a priority in the education of building practitioners from the beginning of their studies and through to continuing professional development
2. Higher education and professional institutions, educators, students, and practitioners should all be committed to this priority
3. Teaching and learning should enthuse and inspire students to rigorously and creatively address design challenges
4. Educators should promote a sustainable approach to design through appropriate pedagogical methods, tools and techniques
5. The pedagogy should encourage critical awareness, responsibility and reflection of the interdependencies within the design process
6. The curriculum should support investigative discourse between different disciplines, parties and professions
7. Adequate time, human and financial resources should be devoted to this pedagogical process
8. Educators, students and professionals should continually evolve the knowledge base of sustainable environmental design through exemplar research and design practice
9. The knowledge base of sustainable environmental design should be disseminated in a manner that is easily accessible to students, academics, practitioners and the general public
10. A sustainable architectural education should have the full support of accreditation and regulatory bodies

PEDAGOGICAL OBJECTIVES AND LEARNING OUTCOMES

Awareness that buildings are responsible for roughly half of worldwide energy consumptions is forcing new demands on educators, students, and practitioners of disciplines of the built environment. For such priority to be consistently considered in curriculum development, pedagogical objectives should build on the most up to date and verified knowledge available and on the results of research and built practice - as well as on policies, national and international qualification frameworks and professional requirements - so as to define the learning outcomes in terms of knowledge, skills and competence in sustainable environmental design that graduates and professionals should acquire at each level of progression towards responsible practice.

The descriptors knowledge, skills and competence derive from the European Qualification Framework for Lifelong Learning (EQF), adopted by the European Commission to act as a “translation device to make qualifications more readable and understandable across different countries and systems” (EC, 2008). Such learning outcomes are proposed here at three subsequent stages, Sensitisation, Validation and Reflection, which could be potentially assumed to correspond to undergraduate (Bachelors), graduate (Diploma or Masters) and postgraduate (Doctorates or post-professional Masters) degrees. However, such correspondence can vary significantly basing on the structure, resources, ethos, and innovation in curriculum development that characterise academic and professional institutions. Two or all of these stages could...
indeed be condensed in one single cycle of higher or post-professional education. Without defining an ‘ideal’ model of curriculum, these three stages - from the exploratory, through a propositive onto a critical approach - are therefore uniquely indented to define a progression of abilities of environmental sustainability centred on the role of design, which students - as well as educators and practitioners - should gradually attain.

### Exploratory approach
- Design studio projects and theoretical lectures introduce and enthruse students to issues of sustainable environmental design.
- Students explore concepts and principles via direct experimentation.

### Propositive approach
- Theoretical knowledge is practiced and produced in the context of architectural design projects.
- Students validate, qualitatively and quantitatively, their knowledge, by research-based design and propose original interpretations.

### Critical approach
- Multidisciplinary exchanges and research-based approaches to design are deepened.
- Students are exposed to scholarly and practice-based research and to its contributions to the design process.

#### Stage 1: Sensitisation
At the first stage of education, the main principles and values of sustainability should be provided as an introduction to contemporary challenges and as drivers of architectural form, transferring enthusiasm and commitment to sustainable design and opening the gates of the skills needed to creatively explore ideas. Students need to be aware of what the challenges are, and therefore have to be provided with the foundations of knowledge on which to construct their learning. The pedagogy should aim towards the formation of a sensitive attitude in the creation of built spaces, from the pragmatic to the poetic. This should help to mitigate potential prejudices, misconceptions and biased opinions on the framework of sustainability.

A pedagogy based on learning by doing, with investigative ‘hands-on’ coursework given at the same time of delivery of knowledge, can engage students in their learning, instigate passion and enthusiasm for sustainability and target the sensitisation of students towards the development of an architectural language informed by sustainable environmental design. The learning environment should become one of cooperation and activity, fostering a dynamic interaction in the lecture theatre as in the design studio. The pedagogy can be reinforced by field trips and illustration of traditional and contemporary case studies. Knowledge of regulatory frameworks should be introduced in the form of benchmarks as a minimum standard to meet, but also as vehicles through which questions can be developed and creativity can be triggered. Students should be provided with rules of thumb that could help inform the design response and contribute to frame the feasibility of the proposed domain of solutions. Basic practical/experiential learning tools could identify the issues at stake and emphasise the importance of a complementary relationship with other disciplines, creating the foundations for a multi/inter/transdisciplinary approach to design. The experiential approach could be nurtured by inquiring the environment in which designs take place.

To facilitate Sensitisation, higher education and post-professional programmes should consider embodying the following learning outcomes in their pedagogical development:

**Students should exhibit knowledge of:**

12 At each stage of education, the term ‘students’ could also include academics and building professionals in the case of continuing professional development activities promoted by higher education institutions or regulatory bodies.
- Key values and principles of sustainable environmental design
- Precedents and environmental attributes of historic and contemporary buildings and urban spaces
- The potential offered by traditional and new materials and technologies to inform design
- Benchmarks and environmental standards at national and international level
- The relation with other disciplines concerned with the construction sector
- The opportunities afforded by the procedures of the building industry and the control of project budgets

Students should also demonstrate appropriate skills to:
- Take a critical position in relation to wider issues and objectives of sustainability and its expanding boundaries (including environmental, socio-cultural, political and economic responsibility)
- Formulate appropriate environmental design strategies for new or existing buildings and urban spaces informed by climate, site, culture, construction, materiality, building type, and occupancy
- Communicate their design explorations and solutions to a specialist and non-specialist audience

Stage 2: Validation

At the second stage of education, students should be exhorted to develop autonomy in design investigations and competence to resolve questions, researching those by appropriate techniques to yield knowledge that can be analysed, quantitatively and qualitatively. Students should be provided with, and should contribute to produce, the knowledge necessary to validate the concepts explored at the first stage of education, together with the abilities necessary to propose innovative strategies for architectural and urban design.

The pedagogy should empower the students to develop personal understanding and motivation towards the framework of sustainability. Educational methodologies should be founded on problem-based learning. A question is asked by the project, the motivation comes from the need to acquire, and produce, the necessary knowledge, engaging in investigation and original interpretation. This approach should achieve the validation of issues of sustainable environmental design, so that students can consolidate, combine, and develop knowledge by evaluating problems and proposing original solutions. The teaching should be supported by exempla of best practice for students to obtain reliable evidence of performance data, and perceive the opportunities inherent in a sustainable approach to design. Courses need to have a clear direction that focuses personal agendas of the tutors to one that adopts sustainability as core to the pedagogy. The role of design as a forum for investigation should be reinforced. Applied coursework should competently address key issues of environmental, social, and economic sustainability, which provide interconnected opportunities that can be creatively addressed in projects. Design, simulation, and verification tools should be introduced to facilitate data analysis, assessment of performance and comparison of scenarios. Knowledge of regulations should be provided, yet - due to a rapidly changing legislative framework - the pedagogy should also offer an understanding of the concepts ‘behind’ regulations so as to promote design innovation.

To facilitate Validation, higher education and post-professional programmes should consider embodying the following learning outcomes in their pedagogical development:

Students should exhibit knowledge of:
- The legislative framework and building practices that include awareness of costs and complexity of execution within creative architectural and urban design

Students should also demonstrate appropriate skills to:
- Identify, compare and assess environmental impacts and performance of buildings
- Make use of on-site observations and measurements, as well as interpretation of performance data and calculated results, to inform design solutions
- Recognize the contribution of architecture and urban design in shaping sustainable environments, societies and economies
- Develop understanding and ability to interface with other professions within the design process

And competence to:
- Promote the propositional nature of design as a generator of new knowledge
- Embrace a multi/inter/transdisciplinary approach in tackling issues of sustainable environmental design
Stage 3: Reflection

At the third stage of education, students should be encouraged to deepen and specialise their interests, critically linking learning with its applications to professional advancement, and committing to cutting-edge scholarly and/or design research, individually or as a leader or key member of a multi/inter/transdisciplinary team. The range of abilities acquired at the first two stages of education should be reinforced and utilised to look comprehensively at the built environment - and the overall architecture and urban design construction process - in a holistic way, also engaging with continuing professional development in research and design, and advocating lifelong learning. Courses could clearly differ according to their specific streaming of specialisation, therefore promoting differentiated knowledge, skills, and competence.

The favoured teaching methodology remains that of the one-to-one tutorial or the seminar group, so as to support a research-based approach to design and also promote multi/inter/transdisciplinary exchanges. The curriculum should be reinforced by transfer of experience, knowledge, methods, and results of scholarly, practice-based, and pedagogical research between academic institutions and with professional bodies, so as to also contribute to bridge the gap between higher education and the practice of design. Research as a learning and design tool should be emphasised, as well as the analysis, verification, and critical reflection on achieved results, promoting a pedagogy based on performance-based learning and design research. Students need to develop reflection and originality in tackling design issues, and this can be supported by the direct analysis, measurement, simulation, and/or verification of built case studies that can inform the development of innovative ideas of design and research. Students should be able to take informed and holistic judgements on the nature of knowledge and should be encouraged to challenge existing knowledge boundaries of sustainability through design explorations or thorough scholarly and/or applied research.

To facilitate Reflection, higher education and post-professional programmes should consider embodying the following learning outcomes in their pedagogical development:

Students should exhibit skills to:
- Take informed and holistic judgements and think critically about the nature of knowledge and how it is produced, validated and expanded
- Relate the knowledge acquired to professional development at the various scales of architectural and urban design
- Analyse and originally interpret environmental codes and performance targets so as to lead to innovative design and/or research solutions

And competence to:
- Commit to cutting-edge scholarly and/or design research, investigating aspects of sustainability individually or as a key member of multi/inter/transdisciplinary international teams
- Engage in life-long learning and continue expanding the boundaries of the existing knowledge of sustainable design

PROGRAMME STRUCTURE AND METHODS FOR TEACHING AND LEARNING

An integrated cognitive framework has been proposed to systematise the contents to be delivered in academic programmes, where the notions and practices of sustainable environmental design can be categorised under the three domains of theoretical (issues and principles), experiential (applications and case studies) and analytic (tools). The methods for teaching and learning could obviously vary, but they should build the knowledge, skills and competence in layers, starting from the initial stages of the education, and incorporating both qualitative as well as quantitative information. A plurality of approaches in terms of programme structure could be adopted to accommodate the delivery of such cognitive framework.

In fact, programmes should be arranged to respond to the specific teaching and learning culture and organisation of the institution concerned, managing accordingly: the delivery of contents, i.e. the stages of the curriculum where knowledge of sustainability is delivered and/or explored; the staff-to-student ratio (SSR), including both theoretical and studio modules; the methods for knowledge transfer, e.g. ex-cathedra lectures, seminars, workshops, etc.; the pedagogical tools, e.g., experiential tools, software, etc.; and the
assessments, i.e. stand-alone examination or integrated with other coursework. Founded on a review of higher education curricula, five models of programme structure have previously been identified:

- **Linear / Parallel**: Each disciplinary area runs in parallel and knowledge is delivered autonomously, with ex-cathedra lecture modules and studio being assessed independently.

- **Partially Integrated**: Taught modules of environmental science / design can represent the link between studio and other core teachings. Although these modules can be taught as stand-alone units, they are generally, at least in part, integrated with other subjects in delivery or in assessment.

- **Fully Integrated**: Studio modules are conceived as working spaces, where contents of different domains converge around the central role of the design project. Theoretical knowledge is delivered in accordance with the requirements, timing, and pace of studio to inform and support the design development.

- **Iterative**: Rather than following a linear sequence of knowledge delivery, acquisition and application, this structure is based on a series of cognitive ‘loops’, where the contents provided at one stage inform the competence acquired in the following.

- **Elective / Minor**: This structure is characterised by various electives - eventually from different degrees and/or Departments - that students can include in their study programme (e.g., a Minor degree).

Each programme structure has its own challenges and opportunities, so it is necessary that the curriculum is supported by adequate approaches to teaching and learning to facilitate knowledge transfer and exploration. Among the potential strategies that can enhance education for sustainability in each model are the following:

- **Develop interconnections between theoretical lectures and design studio**

  The interconnections necessary to acquire and practice a multi/inter/transdisciplinary approach to design, as well as to foster teamwork and communication, can be promoted by environmental / architectural science lectures and design projects that create a direct link between theoretical principles and their applications.

- **Promote a research-based, analytic and holistic approach to design**

  Sustainability is more than just meeting environmental targets, since it is also part of a socially, culturally, economically, and ethically responsible design practice. The process of design and construction of the built environment cannot be based exclusively on subjective aspects, but rather should be founded on a scientific and holistic approach, where each parameter at stake needs to be analysed, critiqued, and evaluated.

- **Increase competence of sustainability at the various stages of the programme**

  Sustainability should not be seen as a separate ‘specialism’ to be delivered as a satellite component of education, but rather it should be integral to the curriculum as an effective inspiration of the design process.

- **Promote the central position of the design studio throughout the curriculum**

  A close relationship between lectures and studio should encourage critical and creative thinking, requiring a properly organised series of projects that evolves throughout the curriculum. Students should be encouraged to develop a meaningful level of competence, where notions are synthesised within the design project.

- **Foster student-centred learning (including the use of e-learning tools)**

  Information and Communication Technologies (ICTs) offer significant opportunities to motivate learners through interactive exchanges with tutors and peers, whilst providing easy and open access to didactic material. Virtual studio environments and advanced tools such as BIM could engage students in tasks from remote locations, expanding the boundaries of learning beyond the confines of the institution, developing skills in team-working, and supporting discussion and communication.

The implementation of the above strategies within each of the five paradigmatic models of programme structure identified could be facilitated by the pedagogical methods described in the following diagrams.

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13 The five models of programme structure here described are presented in detail in the report *EDUCATE Framework for Curriculum Development* downloadable from [http://www.educate-sustainability.eu/educate-framework](http://www.educate-sustainability.eu/educate-framework)
The interconnections between disciplinary areas could be promoted by a transversal integration of seminars, workshops, and case studies that bridge theoretical lectures, environmental science/design, other core modules and design studio. Seminars and focused workshops could foster sensitisation at early stages of the education. At the second stage, the validation, environmental science teaching could be supported by elective courses, whilst at the third stage, the reflection, priority should be given to design studio, supported by guest lectures, investigation of case studies and research-based analysis of design applications.

The interconnections could be promoted by the ‘bridging’ position of environmental science/design modules, reinforced at the second and third stages of education by elective teachings and dedicated studios. Links between environmental aspects could be created by focused workshops, seminars, or case studies, directly connected to theoretical courses, design studio or to both. It is through seminars and workshops that questions could be stimulated and new topics introduced, allowing the development of a holistic approach to sustainability. At the third stage, priority should be given to design studio and research-based investigations.

Interconnections could be reinforced by workshops and seminars on specific contents, or issues proposed to deepen the knowledge, to pose gradually more complex questions and to reinforce the competences acquired. The validation stage could include environmental science lecturers and design projects supported by elective modules. At the third stage, the reflection, theoretical and environmental science lectures could provide additional support to design studio projects. Workshops and seminars at this stage could be principally dedicated to the presentation of case studies and the learning / application of tools for analysis and verification.
Although in this structure there is a clear interdependency between environmental science and design studios across the various stages, interconnections could be reinforced by theoretical lectures and integration of specific seminars and workshops. These seminars and workshops could be an opportunity, at the second stage, to introduce new issues of sustainability (not directly part of the curriculum) or to link, and correlate with studio applications, diverse topics. The third stage could converge to a fully integrated curriculum, where theoretical courses and environmental science lectures are considered as a support to the design.

This structure offers the possibility to create links between the ‘traditional’ curriculum and dedicated courses that students can elect to study, for example in the form of a Minor degree, at any stage of their education. Interconnections between disciplinary areas could be promoted by integration of seminars, workshops, and analysis of case studies that bridge theoretical contents and design applications. These activities, together with research-based experimentations - possibly deriving from, or delivered in conjunction with, courses elected by the students - could be integrated with the main design studio projects.

**PRIORITIES FOR TRANSFER OF THE PEDAGOGY**

Any investigation into how sustainable environmental design can be embedded, integrated, and transferred in curricula of higher education across European and non-European countries needs to consider the role of qualification frameworks, subject benchmarking, and accreditation and qualification criteria. All educational frameworks and subject benchmarking however are not intended as a specification of a detailed curriculum but should allow for “flexibility and innovation in programme design and stimulate academic discussion and debate upon the content of new and existing programmes within an agreed overall framework” (QAA, 2010). Therefore, the learning outcomes previously proposed should not be considered as a substitute for existing educational frameworks, but rather should be read in conjunction and in addition to those.

In terms of programme structure, almost all European countries follow the structure of three cycles for higher education qualifications proposed as part of the implementation of the Bologna process. In some countries, an integrated Master-level study programme of 5 year of duration is still offered, even if, in most cases, the curriculum is organised in similar progressive stages to those recommended by the Bologna process. Most European curricula in architecture and urban design concentrate the delivery of general knowledge and the acquisition of the main skills needed in the design process during the initial level of studies, investing the
graduate cycle (or the last 2 years of the curriculum) in the application of know-how, specialisation, enhancement of life-long learning and research. A global and truly integrated approach towards education for sustainable environmental design is however yet fragmentally adopted in European architecture schools. These contents are, at times, proposed uniquely as elective subjects not available at the beginning of the education, or as modules for specialisation offered at the graduate or postgraduate cycle. In some cases, sustainability is valued as a compulsory component of the education, but usually not during the early stages of the undergraduate cycle. When such contents are effectively delivered, they are seldom comprehensively integrated with design studio or other coursework. Together with the lack of awareness and training of tutors in this disciplinary domain, this shows some of the current limits for implementing sustainable environmental design in an integrated way, and explains the reasons why sustainability is often considered as an added quality to the competence acquired by students, rather than being a fundamental asset of the curriculum. In general, however, higher education and professional institutions in Europe (and beyond) demonstrate serious awareness of the necessity for embedding sustainability in their educational provisions. Also, the notion of multi/inter/transdisciplinarity and the instigation of a research-based approach centred on the core role of design are commonly valued. As a consequence, the following priorities can be advocated to transfer the pedagogical principles and practices herein described at academic and professional level:

- **Promotion of studio culture centred around the challenges of sustainability**

To address the challenges of sustainability in higher education the actions to put in place should encompass:

At the *institutional* level:

- Emphasise the ethical and the socio-cultural values of sustainability across the institution;
- Endorse an institutional vision encompassing sustainability and informing enrolment of staff and students;
- Promote professional development towards sustainability amongst full-time and part-time staff;
- Engage with external experts and the wider community to promote participatory initiatives (live projects).

In terms of *curriculum development*:

- Define learning outcomes of modules embedding consideration of sustainable mandates;
- Support interconnections and cross-fertilisation between different disciplinary domains;
- Establish clearly identifiable criteria and qualitative and quantitative benchmarks for assessment.

To foster *engagement and commitment* in the design studio:

- Promote experiential learning in support of ex-cathedra delivery of information;
- Encourage students to embark on peer- and self-reflection and rigorous evaluation of their design work;
- Adopt integrated teaching and learning methods that reinforce dialogue, communication, and collaboration within multi/inter/transdisciplinary teaching staff teams.

- **Dissemination of knowledge and exempla of best practice (EDUCATE Portal)**

Due to the vast and increasingly growing literature on sustainable environmental design, the EDUCATE project has created an online Portal to facilitate the transfer of information, know-how, results and methodologies to educators, students, practitioners and the public. Amongst other features, the EDUCATE Portal embeds a comprehensive Knowledge Base presenting theoretical, empirical and analytic knowledge of sustainable environmental design. Other than having proved successful in delivering the targeted learning outcomes, the use of e-learning tools such as the EDUCATE Portal may also offer a solution to address some of the current dichotomies within higher education and the practice of architecture, providing the potential to fill the gap between creative design and the application of technical knowledge, and offering new and interactive ways to learn, work, and communicate to both expert and novel users. Such tools can also present a timely response to the challenges that academic institutions are currently facing, such as:

- The need to broaden the geographical boundaries of education and support lifelong learning;
- The increase in enrolment in academic programmes, with more pressure on space and staff time;
- A diverse student body (e.g., international students, professionals based in the workplace, etc.);
- New financial challenges, including evolving expectations within academia and practice;
- Changes in the building industry, with more integrated teamwork and communication between disciplines.
Engagement of professional practice with academic teaching and research

In terms of engagement of professional practice with academic teaching and research, a long-term vision and the promotion of opportunities to foster continuous exchanges of expertise, data from scholarly and practice-based research and know-how should be reinforced. At higher education level, students need to acquire not only knowledge, skills, and competence, but also ability to control the complexity of the building design and construction and deconstruction process in all its interrelated aspects, to anticipate problems of realisation, and approach their design work in an innovative way, but also within a real perspective.

To this aim, the following priorities should be considered by academic and professional institutions:

- Support a direct engagement of building practitioners with academic teaching and learning;
- Promote collaboration of professional practices with scientific and evidence-based research;
- Strengthen the link between practice and academia via the organisation of joint events (e.g., seminars, exhibitions, road shows, design competitions, etc.) involving educators, students and professionals.

Simultaneously, the enhancement of sustainable environmental design in the practice of architecture should become a core issue within the development of expert competence and ethos of practitioners, feeding into the continuing professional development of architects and other figures involved in the construction industry. Legislative frameworks that can enthuse and inspire designers and clients towards the opportunities of sustainability should be promoted, so as to also identify gaps in knowledge and build the requisite know-how, skills, and demands amongst actors of the building market. In this direction, it is important that:

- Subject benchmarking, and accreditation and qualification criteria, embed explicitly sustainable environmental design amongst the knowledge, skills and competence expected of graduates;
- Such knowledge, skills and competence are furthered by compulsory continuing professional development in the multi/inter/transdisciplinary domains of sustainability;
- Professional institutions promote discussion and debate on sustainable environmental design by the creation of knowledge communities, interactive networks, social media, etc. that engage the wider public in the requirements for the responsible advance of architecture and urban design.

As a conclusion, it can be said that at a global level there still is, indisputably, significant amount of debate and lack of consensus regarding the impact of sustainability upon teaching and learning in programmes of higher and post-professional education. Sustainability has been conceived as paradigmatic but also as requiring a paradigm shift in pedagogy to approach it in an effective and meaningful way.

So, does it present a golden opportunity to stimulate pedagogical reform? Or is engagement with sustainability too often tending towards a technicist approach? And how do educators, in diverse contexts interpret the meanings and objectives of sustainability and assess its impact upon the processes of teaching and learning? Does the plethora of calls to better integrate sustainability into the curricula have substantive or, looking behind the rhetoric, relative modest implications for pedagogy?

It would be wrong to assume that educators exhibit a single interpretation of the sustainability agenda and its impact upon teaching. This is hardly surprising, given that the central concept has elicited several hundred definitions and initiated multiple efforts and endeavours in terms of educational practices and the drawing up of national and international regulations. It can however be argued that there is value in exploring the evolution of curricula and pedagogical responses in the effort to interrogate, interpret and integrate the powerful - albeit yet relatively contested - concept of sustainability. Significantly, this ambition does not just involve a change in the content of current educational frameworks and programmes, but rather requires asking deep questions about what, in the context of sustainability, the actual purpose of education is. As a matter of fact, change requires more than mere content: it is by looking beyond uniquely the knowledge delivered that successful education for sustainable environmental design can be achieved.
Criteria for Professional Qualification

SUSTAINABILITY IN THE DESIGN OF THE BUILT ENVIRONMENT

The urgency to mitigate the harmful impacts that buildings and urban spaces have on the environment and the requirement to promote adaptation to climate change scenarios are placing significant demands on practitioners of the built environment. Although several professional practices have embraced sustainability as the primary driver of their design ethos, with relatively few exceptions a general lack of integrated creative and technical skills amongst practitioners has manifested itself through a profession yet generally ill-equipped to handle the substantial paradigm shift involved in sustainable environmental design. Nowadays, a growing legacy of buildings still fails to endorse articulate sustainability goals, and therefore, in the long run, has the potential to harmfully impact on the environment. Conversely, an approach where carbon neutrality and reduction of consumptions have been prioritised over design inspiration, quality of life and psycho-physiological well being of occupants, has frequently hindered the architectural value of the built spaces produced or, indeed, the delight they should bring to those experiencing them. However, this legacy is not universal and it is important not to disregard the many professional practices that holistically embrace sustainability as core to their design agenda and deliver projects that are successful on all fronts.

Within the EDUCATE project, an initial global appraisal of the state of the art of environmental sustainability in the practice of design has allowed to build a comprehensive picture of knowledge and needs amongst architectural firms in European and extra-European countries. This appraisal has been performed through online surveys in which building practitioners were asked to express their opinions and rate priorities with reference to their experience and individual approach to environmental sustainability. The surveys also aimed to the investigation of market requests in terms of the competence sought from both students and professionals, thereby helping to understand the core skills that should be developed at higher education level. When evaluated comprehensively, the results indicate a need to develop an educational framework that caters for both, the needs of those working towards entry to the profession, and the ongoing demands of those already within it. A critical analysis of the outcomes also enables to prioritise expectations in terms of knowledge, skills and competence that graduands and graduates should acquire, and to identify some of the barriers to the embracement of sustainability in professional practice, which can be summarised as:

Knowledge and Education:

• Insufficient training for actors of the built environment, policy-makers, and the wider public
• Misleading information on performance and inaccurate claims (e.g., ‘greenwash’)
• Cultural norms that ignore the creative possibilities afforded by sustainability, still considered as a complex domain, expensive, and of exclusive remit of the specialist
• Lack of a multi/inter/transdisciplinary insight founded on best practice and transfer of knowledge
• Misconceptions on costs (or their perception), prejudices and mindsets that prioritise saving money at the time of investment rather than looking at costs of ownership

Regulations and Standards:

• Inadequate legislative frameworks that fail to create real drivers and demands for sustainability
• Need for clearer standards, whose application is more strictly verified
• Lack of a long-term vision and financial incentives to promote innovation in design

To support the holistic implementation of sustainability in shaping the design of the built environment, it is necessary for professionals to blend advanced technical abilities with the broader set of creative skills brought to bear on finding creative solutions to design problems. They need the freedom to practice these with the support of all the actors of the building market (including clients), and within a regulatory environment that encourages inspirational design rather than being viewed merely as a benchmark to be satisfied. As a result, for equipping future practitioners to operate in an industry inspired by a sustainable attitude to design, there is still work to be done from the bodies regulating access to the profession14.

14 The white paper Criteria for Professional Qualification is available on http://www.educate-sustainability.eu/white-papers
EDUCATION AND TRAINING TOWARDS PROFESSIONAL QUALIFICATION

Conditions for validation and/or accreditation of academic programmes and prescriptions for qualification of practitioners seek to ensure that the standards attained by graduates are appropriate with respect to the professional abilities and ethical formation required for competent practice. Obviously, the criteria in any qualification policy should permit flexibility of approach and could vary significantly from country to country. An analysis of the international state of the art of education and professional training routes allows the creation of a comprehensive picture in relation to the conditions for qualification of practitioners of the built environment. To this aim, various pathways of access to the profession are selected as case studies, encompassing exempla from across the world. Such investigation takes into account the following aspects:

- **Professional Title and Domain of Practice**
  Professional titles that enable the practice of architecture and urban design, and their different levels, are analysed. The specific domains of practice attributed to qualified individuals are investigated.

- **Accreditation of Courses Enabling Qualification for Each Professional Title**
  The courses of academic study necessary for professional qualification are examined together with their regulatory framework and the eventual periodical validation and/or accreditation by regulatory bodies.

- **Internship and Professional Training**
  The periods of regulated practical experience - *internship* (developed before the completion of a graduate degree) or *professional training* (developed after the attainment of a graduate degree) - are identified.

- **Professional Examination**
  An analysis of the professional examination, together with the methodology and the topics of the exam, is implemented. The authorities in charge of the examination and the criteria for evaluation are analysed.

- **Continuing Professional Development (CPD)**
  An investigation of the structure of Continuing Professional Development (CPD) activities and their organisation and regulatory framework is carried out.

- **Other Requirements for Professional Qualification and Accreditation of Curricula**
  The authorities responsible for verification, control, and accreditation of the various stages of academic education and professional training before full qualification and registration as architects are identified.

The analysis of the routes of education and professional training before regulated practice in selected case studies (*page 63*) permits the identification of five paradigmatic models of progression towards qualification.

**MODEL 1**

The requirement for accreditation of academic curricula necessitates the compliance with prescriptive criteria set up by national regulatory bodies, whilst also embracing international regulations. A 4- to 6-year renewal
cycle for the procedure of accreditation can be identified. This can be through evaluation of disciplines or entire academic programmes by external evaluators, or through verification of learning outcomes acquired by students. This model prescribes practical experience initially in the form of an internship for a period comprised between 2 and 12 months. Professional training is also required and can span from 1 to 3 years. In certain cases, additional years of documented practice are needed to obtain an unlimited license. The internship and the professional training are regulated by national regulatory bodies. A professional examination is compulsory for registration. The methodology of examination can include an interview or, in some cases, can imply a series of written tests or a multiple-choice exam, and include the verification of the professional experience acquired as documented by a logbook. In terms of CPD, these activities are required for renewal of the registration with a cycle comprised between 1 to 5 years.

MODEL 2

Academic education is based on programmes that respond to national standards and regulations. There is no formal accreditation procedure in relation to the development of academic programmes, neither in terms of the methods of pedagogy or of assessment of students’ work. Periods of internship throughout the undergraduate education can be recommended but are not regulated. Practical experience in the form of professional training is required after completion of the graduate academic education. When professional training is mandatory, activities such as postgraduate courses can be taken into account in addition to working experience. An examination is compulsory for registration and for practicing the profession. CPD is not compulsory for the renewal of registration, but it can exist in the form of training courses.

MODEL 3

Higher education programmes need to conform to standards either set up for the academic institution as a whole and certified by independent bodies, or on pedagogical frameworks specifically targeting syllabi, or through a validation system endorsed by international commissions. This model includes periods of
compulsory professional experience, both in the form of an undergraduate internship - whose duration can vary between 1 month and 1 year - and of professional training - which can span from 1 to 3 years. The internship is regulated by the academic institutions, while the professional training is supervised by a mentor and is validated by a regulatory body. There is no requirement for a professional examination, nor to certify the professional experience acquired. CPD is not compulsory, nor is it regulated.

**MODEL 4**

Academic curricula are based on programmes that respond to national recommendations and standards set up by regulatory or governmental bodies. A supervised internship is compulsory and is integrated within the undergraduate educational progression. This period of practical experience is regulated by the academic institution and approved by its council. Professional training is not requested for registration. A professional examination is not required in order to access the qualification and the practice of the profession, nor is the demand for further education in the form of CPDs regulated.

**MODEL 5**

This model is atypical with regard to higher education, since the completion of an accredited or validated academic programme is replaced by a professional experience of adequate duration and distinction, attested through commendations, awards, and honours at national or international level. Registration with a professional institution is subject to an examination generally consisting of a portfolio review, including details of completed buildings, and an interview. The requirement for CPD is enforced.
Selected Case Studies of Routes of Education and Training towards Professional Practice
Following the analysis of the case studies and the identification of five paradigmatic models of progression towards qualification, a critical review can be conducted to define patterns of education and training for:

- The development of the knowledge, skills and competence for practicing architecture and urban design;
- The methodologies in place to afford knowledge acquisition and transfer within professional practice;
- The verification of the prescribed learning outcomes throughout the education and training.

The first model implements all the regulated and supervised opportunities in terms of development of knowledge, skills and competence, as well as the provision of adequate methodologies for acquisition and application of abilities and the verification of the outcomes attained. In addition, this model embraces lifelong learning through CPD training. This model is internationally applied prevalently in English-speaking countries.

The second and the third models are generally implemented in European countries. Both of them include requirements for professional training, although not in all countries such practical experience is considered as a compulsory prerequisite for qualification and registration. Nevertheless, recent international regulations - such as the Green Paper for the Modernization of the Professional Qualification Directive 2005/36/EC (COM 2011/367) - highlight the need to complement academic education with professional experience, preferably under the supervision of a qualified professional. The prerequisite of a compulsory professional examination in order to gain access to independent practice is the substantial difference between the second and the third model. When the examination is required, it provides a significant opportunity for verifying the acquisition of the knowledge, skills and competence prescribed by subject benchmarking and by qualification frameworks.

The fourth model doesn’t require regulated professional training neither an examination. Therefore, this model presents limited opportunities for ascertaining the progression of development of knowledge, skills and competence and the methodologies for their acquisition and transfer into professional practice. The same can be said for the verification of the learning outcomes achieved throughout the education and practical training.

The fifth model is atypical with regards to higher education programmes, as the attainment of an academic title is completely replaced by adequate professional experience, evaluated both in terms of its duration and its achievements. In this case, an appropriate regulation and supervision of the progression of development of knowledge, skills and competence - and of the methodologies of acquisition and practical transfer of such abilities - is not applicable, whilst their verification relies entirely on the analysis of the design portfolio and on the professional examination needed for registration.

REGULATORY FRAMEWORK FOR THE TRAINING OF ARCHITECTS IN EUROPE

In order to make the free provision of services within Europe as simple as within individual Member States, the European Parliament and the Council of the European Union adopted in 2006 the Directive 2005/36 on the Mutual Recognition of Professional Qualifications. With this Directive, the system for recognition of professional qualifications across Europe was reformed, helping to make labour markets more flexible, further liberalising the economy, encouraging more automatic recognition of qualifications, and simplifying administrative procedures. In October 2007, at the end of its transposition period, the Directive 2005/36/EC replaced some fifteen previously existing Directives in the field of the recognition of professional qualifications, providing the first comprehensive modernisation of the European system since its introduction over 40 years ago.\(^{15}\)

The Directive 2005/36/EC, Section 8 Architects, Article 46 Training of Architects defines the duration of the academic education of architects in Europe and the knowledge and skills to be acquired. These contents have recently been subject to an ex-post evaluation, with the aim of exploring additional potential for mobility of qualified professionals and for a more integrated services market. In June 2011, the European Commission published a Green Paper on Modernizing the Professional Qualifications Directive that went through a further discussion process, for leading in December 2011 to a Proposal for a Directive of the European Parliament and of the Council amending Directive 2005/36/EC on the recognition of professional qualifications and Regulation on administrative cooperation through the Internal Market Information System (COM (2011) 883).

\(^{15}\) In addition, the notification process prescribed for all European academic degrees has opened the possibility for students to transfer - while studying - from one university to another, across European Member States.
Proposal Com (2011) 883

Within the *Proposal COM (2011) 883*, the original Article 46 of the Directive 2005/36/EC is replaced by the following (the new text is here highlighted in bold characters):

“Training of architects

1. The duration of the training as an architect must be at least six years which may also be expressed with the equivalent ECTS credits. The training in a Member State shall comprise any of the following:
   
   (a) at least four years of full-time study at a university or comparable teaching institution leading to successful completion of a university-level examination and at least two years of remunerated traineeship;
   
   (b) at least five years of full-time study at a university or comparable teaching institution leading to successful completion of a university-level examination and at least one year of remunerated traineeship.

2. The study, which must be at university level, and of which architecture is the principal component, must maintain a balance between theoretical and practical aspects of architectural training and guarantee the acquisition of the following knowledge, skills and competences:

   (a) ability to create architectural designs that satisfy both aesthetic and technical requirements;
   
   (b) adequate knowledge of the history and theories of architecture and the related arts, technologies and human sciences;
   
   (c) knowledge of the fine arts as an influence on the quality of architectural design;
   
   (d) adequate knowledge of urban design, planning and the skills involved in the planning process;
   
   (e) understanding of the relationship between people and buildings, and between buildings and their environment, and of the need to relate buildings and the spaces between them to human needs and scale;
   
   (f) understanding of the profession of architecture and the role of the architect in society, in particular in preparing briefs that take account of social factors;
   
   (g) understanding of the methods of investigation and preparation of the brief for a design project;
   
   (h) understanding of the structural design, constructional and engineering problems associated with building design;
   
   (i) adequate knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against the climate;
   
   (j) the necessary design skills to meet building users’ requirements within the constraints imposed by cost factors and building regulations;
   
   (k) adequate knowledge of the industries, organizations, regulations and procedures involved in translating design concepts into buildings and integrating plans into overall planning.

3. The remunerated traineeship must be carried out in a Member State, under the supervision of a person providing adequate guarantees regarding their ability to provide practical training. It must be undertaken after the completion of the study referred to in paragraph 1. The completion of the remunerated traineeship must be attested to in a certificate accompanying the evidence of formal qualifications.

4. The Commission shall be empowered to adopt delegated acts in accordance with Article 58a to specify:

   (a) the adequacy of knowledge of items as set out in point (i) of paragraph 2, and the necessary competences such degree of knowledge entails in line with technical progress and recent educational developments;

   (b) the need for design skills as referred to in point (j) of paragraph 2, and the necessary competences such degree of skills entails in line with technical progress and recent educational developments”.
The substantial differences between the training of architects as characterised within the Directive 2005/36/EC and the proposal for its amendment COM (2011) 883 mainly consist of the following aspects:

- The extension of the minimum duration of full-time studies from four to six years, with the introduction of a compulsory supervised and remunerated traineeship of one or two years of duration basing on the period of academic education;
- The introduction of the indicator ‘competence’ amongst those qualifying the level of attainments expected of graduates of an academic programme;
- The possibility to further specify the adequacy of the knowledge, skills and competence entailed by points (i) and (j) of Article 46 in line with current challenges and educational progress.

It must be noted here that, as far as achievement of learning outcomes is concerned, the Directive 2005/36/EC in its Article 46 “Training of Architects” simply repeats the 11 prescriptive principles listed in the Architects’ Directive 85/384/EEC of 10 June 1985, the fundamental Directive that for 22 years has provided the basis for the recognition of architectural qualifications within European Member States. Undeniably, the priorities behind the agenda of architectural education have changed substantially over the past three decades.

**KNOWLEDGE, SKILLS AND COMPETENCE IN SUSTAINABLE DESIGN**

In the EDUCATE white paper *Sustainable Architectural Education*, a set of learning outcomes defining the knowledge, skills and competence in sustainable environmental design that graduates and practitioners should acquire have been proposed at three stages, *Sensitisation*, *Validation* and *Reflection*. These stages could be potentially assumed to correspond to undergraduate, graduate and postgraduate degrees, although such correspondence could vary basing on the curriculum on offer at academic and professional institutions. Two or all of these stages could be condensed in one single cycle of education. In order to verify the potential for transferability at a European (and potentially global) level of such learning outcomes, a critical review has been carried out to verify their compliance with the regulatory framework established by the Directive 2005/36/EC and the proposal COM (2011) 883. This critical review leads to the conclusion that the proposed learning outcomes are implicitly incorporated within all the essential training requirements of the 2005/36/EC.

**Sensitisation Stage**

At *Sensitisation* stage, students should exhibit knowledge of:

- Key values and principles of sustainable environmental design (*linked to 2005/36/EC Art. 46 a; b; c; d; e; i*);
- Precedents and environmental attributes of historic and contemporary buildings and urban spaces (*linked to the 2005/36/EC Art. 46 b; e; h*)
- The potential offered by traditional and new materials and technologies to inform design (*linked to 2005/36/EC Art. 46 b; h; i*)
- Benchmarks and environmental standards at national and international level (*linked to 2005/36/EC Art.46 j; k*)
- The relation with other disciplines concerned with the construction sector (*linked to 2005/36/EC Art. 46 k*)
- The opportunities afforded by the procedures of the building industry and the control of project budgets (*linked to 2005/36/EC Art. 46 j; k*)

Students should also demonstrate appropriate skills to:

- Take a critical position in relation to wider issues and objectives of sustainability and its expanding boundaries (including environmental, socio-cultural, political and economic responsibility) (*linked to 2005/36/EC Art. 46 d; f*)
- Formulate appropriate environmental design strategies for new or existing buildings and urban spaces informed by climate, site, culture, construction, materiality, building type, and occupancy (*linked to 2005/36/EC Art. 46 i; h*)
- Communicate their design explorations and solutions to a specialist and non-specialist audience (*linked to 2005/36/EC Art. 46 f; g*)
Validation Stage

At Validation stage, students should exhibit knowledge of:

- The legislative framework and building practices that include awareness of costs and complexity of execution within creative architectural and urban design (linked to 2005/36/EC Art. 46 j; k)

Students should also demonstrate appropriate skills to:

- Identify, compare and assess environmental impacts and performance of buildings (linked to 2005/36/EC Art. 46 e; h; i)
- Make use of on-site observations and measurements, as well as interpretation of performance data and calculated results, to inform design solutions (linked to 2005/36/EC Art. 46 a; i)
- Recognize the contribution of architecture and urban design in shaping sustainable environments, societies and economies (linked to 2005/36/EC Art. 46 e; f)
- Develop understanding and ability to interface with other professions within the design process (linked to 2005/36/EC Art. 46 k)

And competence to:

- Promote the propositive nature of design as generator of new knowledge (linked to 2005/36/EC Art. 46 f)
- Embrace a multi/inter/transdisciplinary approach in tackling issues of sustainable environmental design (linked to 2005/36/EC Art. 46 a)

Reflection Stage

At Reflection stage, students should exhibit skills to:

- Take informed and holistic judgements and think critically about the nature of knowledge and how it is produced, validated and expanded (linked to 2005/36/EC Art. 46 a; f; g; k)
- Relate the knowledge acquired to professional development at the various scales of architectural and urban design (linked to 2005/36/EC Art. 46 b; c; d)
- Analyse and originally interpret environmental codes and performance targets so as to lead to innovative design and/or research solutions (linked to 2005/36/EC Art. 46 e; h; i; k)

And competence to:

- Commit to cutting-edge scholarly and/or design research, investigating aspects of sustainability individually or as a key member of multi/inter/transdisciplinary international teams (linked to 2005/36/EC Art. 46 a; e; f; k)
- Engage in life-long learning and continue expanding the boundaries of the existing knowledge of sustainable design (linked to 2005/36/EC Art. 46 b; c; i; j)
PROPOSAL FOR A REVISION OF DIRECTIVE 2005/36/EC

Within the Directive 2005/36/EC Section 8, Article 46(2), the possibility of amending the knowledge and skills listed in Article 46(1) is taken into account: “The knowledge and skills listed in paragraph 1 may be amended in accordance with the procedure referred to in Article 58(2) with a view to adapting them to scientific and technical progress” (EC, 2006a). Within the Proposal COM (2011) 883, Article 46(2) is replaced by Article 32(4), which gives the possibility to the Commission of adopting delegated acts to specify the adequacy of knowledge, skills and competences of items as set out in points (i) and (j) of Article 46(1) of 2005/36/EC in order to be in line with “technical progress and recent educational developments” (EC, 2011b). Based on the critical review of the learning outcomes proposed by EDUCATE in the white paper Sustainable Architectural Education, a proposal is herein made to include two revisions to Article 46 of Directive 2005/36/EC in its amended format as presented in the Proposal COM (2011) 883.

The first revision aims to make more explicit the priority that should be given to principles of sustainable design in the academic and professional education of architects (proposed text is in bold character):

Original format as per COM (2011) 883:

Art. 46(2). The study, which must be at university level, and of which architecture is the principal component, must maintain a balance between theoretical and practical aspects of architectural training and guarantee the acquisition of the following knowledge, skills and competences:

Proposal for Revision:

Art. 46(2). The study, which must be at university level, and of which architecture is the principal component, must maintain a balance between theoretical and practical aspects of architectural training. Sustainable design must be considered as an integral part of architectural training from the beginning of the study and through continuing professional development. As a whole, the study must guarantee the acquisition of the following knowledge, skills and competences:

The second revision addresses the knowledge, skills, and competences of items as set out in points (i) and (j) of Article 46(1) of 2005/36/EC (proposed revisions are in bold character).

Original format as per COM (2011) 883:

Art. 46(1) (i) adequate knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against the climate;

Art. 46(1) (j) the necessary design skills to meet building users’ requirements within the constraints imposed by cost factors and building regulations;

Proposal for Revision:

Art. 46(1) (i) adequate knowledge of physics, technologies and functions of buildings and urban spaces so as to provide comfort and environmental qualities indoors and outdoors;

Art. 46(1) (j) the necessary design skills to meet building users’ requirements within the opportunities provided by cost factors, building regulations and sustainability

STRATEGIES AND PRIORITIES TOWARDS SUSTAINABLE DESIGN PRACTICE

Five paradigmatic models of education and training routes leading to professional qualification have been here identified. In order to strategically engage key actors of the building industry to implement coherent and verifiable qualification criteria in support of a sustainable practice of architecture and urban design, a framework aiming at measuring and substantiating the acquisition and application of knowledge, skills and competence in environmental sustainability can be proposed. Such framework can be based on the evaluation of the contents, methods, and outcomes of academic and professional formation and can be centred on the five steps that characterise the progression towards qualified practice: Academic Education; Internship; Professional Training; Professional Examination; and, Continuing Professional Development.
1. **Academic Education**

The appraisal of the *contents* - and, in some cases, of the pedagogical *methods* - of higher education can be assured by validation of programmes and syllabi or by cyclical accreditation. Validation and, in particular, accreditation give strong emphasis to the *outcomes* of the educational processes by analysis of the performances of students and the knowledge, skills and competence that they have acquired.

2. **Internship**

The verification of the *contents* of the internship can be enforced by the nature of a programme regulated according to national legislation. The internship can be generally developed in collaboration with academic and/or professional institutions that are responsible for validating the *methods* of knowledge acquisition and application, and the *results* of the practical experience (for example, in the form of a log book or portfolio).

3. **Professional Training**

The evaluation of the *contents* of the professional training can be implemented by a structured programme framed within national regulations and conducted in close cooperation with higher education and professional institutions. These bodies can accredit and validate the *methods* and *outcomes* of the practical training before granting access to examination (maybe with exemption from some parts) or to qualification.

4. **Professional Examination**

The evaluation of the *contents* of the professional examination can be put into effect by an adequate selection of the themes of assessment. The quality control of the process of examination, and of the selection of the members of evaluation panels involved in its procedures, contributes to ascertain the appropriateness of the *methods* of the examination, while the results are verified by monitoring of the final *outcomes* of the professional exam.

5. **Continuing Professional Development**

The verification of the *contents* of further education can be based on a structured programme of CPD organised on a pre-set national curriculum. The validation of the *methods* of knowledge acquisition can be supported by certification of the CPD, and of its organising institution, from the regulatory body. The analysis of the *outcomes* can be verified by submission of certificates of attendance or via self-assessment.

The implementation of this framework, and in particular of the steps related to the internship and the professional training, assumes particular importance in Europe in light of the recent Proposal COM (2011) 883. Such proposal suggests the extension of the minimum duration of full-time studies from four to six years with respect to Directive 2005/36/EC, and recommends the introduction of a compulsory supervised period of 1 to 2 years of remunerated traineeship as part of the progression towards qualification.

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**Learning Outcomes of Sustainable Environmental Design Potentially Enhanced by Professional Training**

- Acquire knowledge of the principles and practices of sustainable environmental design
- Understand the environmental impacts of design decisions
- Develop skills in the use of sustainable building materials and technologies
- Foster an attitude towards innovative and sustainable solutions in the field of environmental design
- Communicate effectively with interdisciplinary teams
- Demonstrate proficiency in the use of appropriate tools and software for sustainable design

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*European Community Model as per COM 2011/883/EU*
Building on the results and proposals previously outlined, it is possible to define a set of priorities in support of knowledge, skills and competence in sustainable environmental design that need to be explicitly embedded in subject benchmarking and qualification frameworks. These priorities should encompass:

- A comprehensive multi/inter/transdisciplinary academic education and professional training for all actors of the building market centred on the values of sustainable development;
- Lifelong learning, enforced by compulsory Continuing Professional Development, to enhance the opportunities offered by new knowledge and information, regulations, and governmental initiatives;
- Integration in the practice of architecture and urban design of the results of research activities related to sustainability, as well as know-how of traditional skills, local materials, and building techniques;
- Access to reliable data and benchmarks in terms of costs, performance, and evaluation of payback;
- The organisation of freely accessible conferences, seminars, courses, together with the production of literature and publications, communication via the web and on-line learning, in order to allow a broad dissemination of principles and values of sustainable design, and of exempla of best practice.

In promoting the implementation of sustainable environmental design in the practice of architecture, evidently, a primary role can be played by governments and regulatory institutions via the formulation and application of adequate legislative frameworks, thus suggesting:

- The need for a top-down approach with a major governmental commitment to sustainable design;
- Reinforced communication between the architectural profession and regulatory institutions;
- Clear and streamlined mandatory regulations and benchmarks (e.g., codes, standards, energy certification) supported by appropriate verification of their application;
- Legislation able to enhance design opportunities and means of architectural expression.

In summary, the activities of many legislative and professional bodies reveal that there is a global desire for explicit and measurable indicators that regulate access to the design of the built environment, and nurture the embrace of environmental sustainability in the education, training, and practice of architecture and its related disciplines. To these aims, it is necessary that such requirements represent a core concern within the formation of professional competence and ethos of the practitioners. This is challenging a substantial revision of the formation route that grants access to independent practice, starting from the academic curricula up to the lifelong learning and professional development of actors of the building industry.
Promoting Sustainability in the Design of the Built Environment

DISSEMINATION ACTIVITIES

Throughout the development of the EDUCATE project, partners have continuously engaged students, academics, practitioners, representatives of industry and professional bodies, as well as the general public, in a series of workshops and symposia that have been organised to disseminate know-how and exempla of best practice of environmental sustainability, and to encourage change of behaviour, demands and expectations towards the integration of sustainable principles in the design, construction and operation of buildings. Events have attracted a total of more than 600 participants and have been scheduled in conjunction with Consortium Management Meetings at each EDUCATE partner institution in Europe.
Partners and Delegates at the Technical Workshop held in Seville (Spain) in January 2010

Partners and Delegates at the Educational Workshop held in Munich (Germany) in June 2011

Partners and Delegates at the Symposium and Award Ceremony held in Rome (Italy) in February 2012

Partners and Delegates at the Symposium held in Louvain-la-Neuve (Belgium) in May 2012
Further dissemination activities have included the construction and development of the project’s web page (www.educate-sustainability.eu), which throughout the duration of EDUCATE has been continuously updated so as to widely transfer information, news, events, downloadable documents, etc. The final version of the EDUCATE website features all the publications produced by the project and a link to the freely available online Knowledge Base on sustainable environmental design (https://www.educate-sustainability.eu/kb/).

The communication strategy has also consisted in the distribution to several hundred recipients of monthly electronic newsletters in the form of News Feeds and/or as a 1-page e-mail attachment - also downloadable from the EDUCATE web site - in order to keep the public aware of the developments of the project. Further to this, to better reach students, educators, practitioners and other actors of the building industry - and therefore widely circulate the results of the project - the dissemination has also included the publication, at key stages of advancement, of printed newsletters, which have been translated in six languages (English, French, German, Italian, Spanish, and Hungarian) to span the entire geographic boundaries of EDUCATE.

The EDUCATE website (left) and the online Knowledge Base (right)
CONCLUDING REMARKS

During the three years of its development, EDUCATE has been fully engaged in providing a pedagogical and professional platform that could contribute towards the successful implementation of sustainable environmental design and energy efficiency as creative factors in the education and practice of architecture. The potential impacts of the project, in the short as in the long term, could be appraised primarily by:

- Learning outcomes of students, as incorporating principles of environmental sustainability in architecture and urban design. This could be measured on the analysis of trends in students’ grades in subjects that integrate sustainable design, environmental science and energy-related taught modules; increase of students’ satisfaction on pedagogies (e.g., evaluation of teaching); and, feedback from academics, practitioners, external examiners and validation authorities concerning the implementation of sustainable values and practices in the curricula, and their potential positive effects in the future building industry.

- Adoption of the proposed principles for sustainable architectural education and criteria for professional qualification by academic institutions and regulatory bodies at a European and global level. This would contribute to remove some of the current pedagogical and professional barriers to the effective integration of environmental sustainability in higher education and in the practice of architecture, and would fill a gap in current regulations as reflected in the loose requirements of most legislative frameworks in measuring and verifying the knowledge, skills and competence in sustainable environmental design required of graduates and practitioners along the training route that leads to professional registration.

- Dissemination of know-how and exempla of best practice of environmental sustainability to students, educators, practitioners and, above all, the public via the EDUCATE Portal and its Knowledge Base. In the long term, this could contribute to increase the diffusion of a sustainable approach to design amongst actors of the building industry and stimulate changes in behaviour and demands by the public (e.g. clients, homeowners), with measurable impacts on the achievement of environmental targets at a local and global level, in terms of energy efficiency, reduction of CO₂ emissions and management of resources.

To respond to the challenges of the current climate (and economic) crisis and guarantee a sustainable future to human activities, the building industry nowadays demands graduates of disciplines of the built environment able to face a range of integrated issues, which include - other than abilities in creative design - also awareness and familiarity with themes of environmental sustainability and energy efficiency. For this to take place, a comprehensive process of revision of higher education and professional training is needed.

A number of obstacles can hinder the successful implementation of such process, although also several opportunities can foster the attainment of this objective. Efforts and initiatives such as the EDUCATE project testify of the growing appreciation of the need to break out of conventional disciplinary compartments and bridge divides between creative expressions and technical sciences, theory and practice, learning in academic and non-academic environments, and reiterate the need for a holistic approach in the formation of the current and future generations of building practitioners. Other than providing knowledge, skills and competence - as well as the ethical foundations - needed for responsible practice, programmes offered by higher education institutions and professional organisations must cultivate critical capacities, cross-referencing and imaginative reflection, supporting meaningful dialogue between disciplinary domains and promoting environmental sustainability as the ultimate aim of any pedagogical process.
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• AIA, American Institute of Architects: [http://www.aia.org/](http://www.aia.org/)

• ANECA, National Agency for Quality Assessment and Accreditation: [http://www.enqa.eu](http://www.enqa.eu)

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• MÉK, Chamber of Hungarian Architects: [http://www.mek.hu/](http://www.mek.hu/)

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