TEACHING INNOVATION AND THE USE OF SOCIAL NETWORKS IN ARCHITECTURE: LEARNING BUILDING SERVICES DESIGN FOR SMART AND ENERGY EFFICIENT BUILDINGS

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Abstract
Today’s buildings are evolving from structures comprising unchanging, static elements scantily able to interact with their surroundings, towards complex systemic compounds with an impact on the environs that entails more than mere anthropic alteration. In pursuit of energy efficiency and true sustainability, buildings must acquire the ability to interact as well as to generate synergies. The most prominent features of this approach are energy management and information flows which, intelligently designed, not only enhance buildings’ capabilities, but also introduce a significant change in their relationship with the surrounds (‘smart cities’) and its inhabitants. This new paradigm calls for revisiting undergraduate architectural instruction, adopting a more complex overview of energy use and management in the design process, regarding buildings as dynamic rather than static entities. The methodology focuses on creating learning environments that favour students’ participation in problem solving and assessment, encouraging teamwork based on case studies and stressing the connection between this new architecture, ICTs included, and social networks as participatory design tools. These ideas were implemented in a pilot learning experience conducted at the University of Seville for undergraduate students. The use of ICTs and the collaboration of non-academic experts were observed to further student promotion and projection beyond the academic environment and introduce them to the professional community.

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INTRODUCTION

One of the major challenges facing contemporary architecture is to mainstream energy-efficient, eco-friendly features in building design. Such features must be maintained across their entire service life. Provision must be made to monitor buildings’ dynamic behaviour over time and favour their satisfactory operation and use. Current trends in the European Union denote the need for significant changes in energy system operation and interaction with occupants: in other words, a new approach to buildings must be instituted to replace today’s models. To lighten their environmental impact, buildings need a new focus, with changes in models, analytical tools, new technologies and most significantly, in the mind-set of all the actors involved. This change in paradigm must be reflected in architects’ and architectural engineers’ training (Vassigh, 2014; Hawas et al., 2017; Salama, 2012; 2015). This article describes a specific course or subject that attempts to holistically coordinate the implementation of solutions to this suite of problems.

The educational proposal aims to explore essential aspects of the use of building energy, control of indoor comfort, quality and healthfulness, and the due treatment of climate in building design. These aims are addressed globally in a comprehensive proposal in which students are guided toward an integrated design methodology that embraces an inclusive package of energy- and environmental sustainability-related considerations.

The lessons covered include characterisation of the energy behaviour of the building envelope, its siting, energy facilities, performance assessment and its potential optimisation, the use of renewable and non-conventional energy, as well as the institution of ICT-supported management and control systems and the design of intelligent buildings.

The project is designed to enable students to:

- understand and apply technical and scientific principles on which building energy behaviour, its establishment and systems are based;
- assess the pros and cons of different technologies to design comfortable indoor environments adapted to use and energy impact;
- acquire the knowledge needed to analyse and critically discuss the environmental and energy values of buildings;
- determine how to best use renewable energy in global and complex architectural proposals.
- make a more effective professional impact through the use of social networks.

METHODOLOGY

Active techniques, particularly the problem-based learning (PBL) approach, are the key drivers of recent revisions in engineering and architectural education methodology (Malmi et al., 2016; Felder et al., 2000; Nabih, 2010).

The need for a different focus in educational methods to reinforce students’ effective acquisition of skills has led to the adoption of techniques such as PBL (Beddoes et al., 2010), either as a supplementary tool in traditional course syllabi (Solis et al., 2012), as a stand-alone approach or in some cases as an exhaustive curricular overhaul (Pierrakos et al., 2016). Such revisions advocate for a change in the educational paradigm to gear it essentially towards skill-based learning in which PBL is the primary mechanism for evolution. The idea is to strengthen the interconnection between what is learnt and what is demanded by the industry and society at large (Burns, 2017). Skills acquisition can be understood as a
combination of knowledge, ability, art and focus in pursuit of a given purpose, in this case, professional qualifications. As a result of their training, students must be able to generate a product applicable to the professional market in which they will practise.

Classroom Dynamics

Student instruction is broached as an ongoing workshop with a direct impact on social networks that showcases their designs and constitute a source of feedback. The outcome of the workshop, where the various techniques and approaches are implemented, should be a viable architectural product, in keeping with the main course requisites and concerns.

In each edition, the PBL-generated element proposed addresses a different issue, a ‘hot topic’ related to current trends. This affords students a broad repertoire of examples from which to launch their discussion or analysis, accessible to the University of Seville’s entire student body on its communication platforms.

Examples of this approach include the work undertaken in previous years based on the ASHRAE Student Competition to design a building in China for the Beijing Municipal Authority and the present project that replicates the university competition sponsored by ASHRAE and the U.S. Department of Energy, RACE to ZERO. The course ends with a proposal for an EPBD horizon 2020-compliant design (taking the EnergyStar specifications as a reference, given the differences in the definition of ‘zero’ in different areas of Europe).

This workshop, the inductive backbone for the course, is combined and cross-referenced with a deductive task, normally consisting in the review and audit of a building renowned for its energy efficiency and sustainability. In recent editions the LEED-accrredited building designs chosen were analysed to comprehend both their specific values and the inter-relational approach to design adopted.

Subject dynamics include the translation of game mechanics to the educational-professional domain (‘gamification’). The aim is not only to obtain better results by motivating students more effectively, but also to reproduce professional situations more accurately. The game model works because it motivates students, creating a commitment and inspiring a desire for self-improvement (Robinson, 2007). All these tools and techniques are intertwined to organise the course around its main driver, an Energy Optimisation Game in which students apply the knowledge acquired. Students compete in teams or ‘companies’ of four to design the building with the lowest energy use ratio. Their final mark and other parallel rewards are associated with the results of this ongoing game.

The course format consists of weekly workshops in which general open discussion is fostered and routine readings and analysis of case studies are recommended as references for possible application in each company’s (team’s) proposals.

That work is reinforced from time to time with master classes on issues directly applicable to team proposals, although not delivered as structured lessons. These exercises help students experiment with the use of environmental technologies in contemporary buildings. The classes are delivered both by course professors and outside experts from the profession. By way of example, the classes envisaged include:

- i-maintenance as a tool for ensuring building performance during the operational stage;
- self-monitoring data-based service cost and energy savings support;
• use of LED technology as a tool for building nZEB buildings;
• distributed control system component architecture and other features.

This methodology includes the ongoing and open review of student progress via team proposal monitoring, as in a forum or congress, so all members can benefit from the information or skills acquired by all other participants. This dynamic method furthers student participation and critical analysis. Whilst the technique can be associated with traditional teamwork, it is based much more firmly on the notion of working in a cooperative enterprise in which all team members are builders and beneficiaries of the professional activity.

Social Networks

This approach is designed to the ‘open wall’ post system in which outside agents can both visualise and intervene in educational activities. It entails the use of social networks and communication technologies: Facebook, Instagram, YouTube, Twitter. With these resources, participants can combine presentations, online documents, videos, photographs and so on.

The subject has its own online identity, essentially in the form of Facebook and Twitter accounts. A portfolio for the subject has also been created in communities such as BEHANCE to upload students’ projects for dissemination among users outside university circles. This simple form of gamification aims to encourage the sharing of information published in a blog, in keeping with Grant’s theory of rewarding acknowledgement (Grant, 2014). Such measures further team feedback in the form of contributions, contrasts and suggestions from non-classroom followers, fostering other actors’ participation and helping refine students’ ability to critically analyse information when faced with such unfiltered stimuli, much as they would in competitive professional situations.

Students’ projects are also assessed by collaborating companies, which reward the one most fully developed, ensuring public acknowledgement and dissemination for students’ work. That, in turn, enhances their motivation and establishes ties with the industry. In 2014-2015 the course was sponsored by Iguzzini Lighting and in 2014-2015 also by Daikin. One of the course fundamentals is participants’ contact with the industry, in particular with the companies most deeply involved in energy efficiency and building intelligence solutions.

DISCUSSION

According to Edgar Morin’s (1999; 2007) theory of complex thinking, reality is understood and simultaneously explained from all possible perspectives; students create their designs globally bearing in mind all the complexities of the respective conditioning factors. At times they apply inductive and at others deductive or comparative methods.

The inductive method is enlisted when studying the object and a given context to draw general conclusions that could be applied to other similar case studies. This encourages student experimentation and active participation.

Problem-based learning

All the components of architectural and architectural engineering design, including the various stages of construction and their characteristics, are studied from the perspective of this acquired complexity.
Students learn to critically analyse the complexities of building siting, physical context and boundary conditions.

The course project is consequently implemented by distributing the tasks to individual team members who subsequently integrate all these contributions jointly as a team or company. The various sub-projects are based on individual analysis of a sustainable and efficient design, further to standard professional practice. One of the critical elements identified is local climate, along with microclimatic factors, particularly in connection with heat island effects (Figure 1).

![Temperature and precipitation graph](image1)

![Wind rose graph](image2)

**Figure 1:** Study of local climate (Source: ISDEEI students work, year 2015).

Here students take into consideration not only building shape, but all its social and functional conditioning factors, such as communications, areas of influence, public transit, capacity for private vehicle management and alternative mobility solutions (Figure 2).

Another factor included in team analysis is plot conditioning and reuse, along with restoration of the damaged habitat and the furtherance of biodiversity to control erosion and settling in the interaction with the surrounds. The contributions of all team members ultimately give rise to an appropriate site on which all the analyses converge.
In the following sub-projects students analyse both the design of the architectural element and the techniques and technologies to be deployed (Figure 3):

- economy of materials and resources to reduce life cycle impact;
- study of the local climate, with proposals for energy optimisation: energy management and production with renewables, GHG abatement, low impact coolants, lighting and thermal control;
- efficient water consumption, including mechanisms such as permeable pavements, landscaped roofs, ponds, autochthonous plants with low water demands, and rainwater harvesting.

The final part of the task involves designing an intelligent building management system, including communication and monitoring facilities, automatic meter reading, control of physical parameters and user interaction.

The indoor environment constitutes an essential concern in all efficiency proposals. It is monitored through a process parallel to the main exercise, deploying post-occupancy surveys (Ban-Huat, 2013), in this case on the case study of an existing building. The aim is to develop the ability to analyse operating conditions, evaluate end user satisfaction with the building designed and understand the problems that frequently arise around similar buildings or specific techniques (Figure 4). Such analyses can be extrapolated to the final version of the course project. The process is very straightforward, for the building analysed, normally the main source of practical information, has a substantial impact on decision-making around the problems encountered.
Social networks

In actual practice, the inclusion of today’s social media proved to constitute strong encouragement for students to improve their projects with a view to dissemination through social networks.
the subject’s Facebook or Twitter accounts where they could discuss and display their work and further their professional profile.

The experimental use of social networks for dissemination yielded fairly good results. Although the subject had been on the curriculum for only 2 years, its impact in those media remained high throughout the academic year at issue. More promising yet was the fact that after the school year was over, the notion of belonging to a ‘community’ persisted among the subject’s followers, who continued to visit the respective Facebook and Twitter profiles and to show an interest in new developments. The outcome was student retention of what they learned in the course longer than with traditional instruction.

A blog was also created for inquiries and suggestions as well as to share information and findings. A diary was kept of work progress in academic, practical and analytical classes, lectures and in situ visits. Hosted on the University of Seville’s Virtual Learning website, it was accessible to group members only, who could use it to discuss the doubts arising around course work in a more private environment. This blog enabled students to keep account of their own group’s work and freely express their opinions about others’. The existence of social network accounts for the subject also generated healthy competition that prompted all students to become more involved in the work at hand and pursue self-improvement.

The votes held in these media proved to be popular and participation was high both among class members and others. The rapprochement between academic and professional practice achieved through the understanding and interpretation of the real works visited was the driving force that led to the award of prizes for student panels by energy efficiency companies.

CONCLUSIONS

The course focus affords a comprehensive and student-friendly approach to a suite of skills of great complexity and technical difficulty. Transferring responsibility for the design, depth and breadth of a learning strategy to team members favours student involvement. The application of knowledge to a realistic and comprehensive exercise enables students to view the actual dimensions of the problem, as would any practising professional.

Learning is reinforced with continuous feedback both from the entire class as a discussion group and from outside actors, for which purpose particularly significant use is made of social networks. Such information management is one of the keys to the course.

The methodology provides a complex approach to architectural creation, with the inclusion of energy efficiency and sustainability issues, understood as a continuum, as part of the primary corpus. Interaction with the urban surrounds and climate are addressed in addition to more traditional conceits. Particular emphasis is placed on occupants and their well-being. The inclusion of control logic and self-monitoring supports the notion of maintaining performance levels throughout the building’s service life.

One of the most significant procedures is the possibility of deploying role dynamics to solve the suite of distributed problems comprising the case study. Participation in team tasks should enable students to perform different roles in different activities, as designers, analysts, collaborators or auditors. The use of game techniques and more specifically the ‘Energy Game’ in teams of four renders the course especially dynamic and fosters active, ongoing and self-encouraged participation while generating notable synergies.
With the furtherance of the use of blogs and wikis in connection with social network management, students can identify the activities undertaken and heighten their class participation and involvement while gaining visibility for their future careers as architects or architectural engineers.

The use of ICTs and the collaboration of non-academic experts further student promotion and projection beyond the academic environment and introduce them to the professional community. In addition, a number of vehicles are used to disseminate information on the subject: social networks, journals, congresses, the Seville School of Architecture’s Facebook page ArquitecTICa_ETSAS and the Twitter hashtag @ArquitecTica.

REFERENCES


