Knowing, showing and understanding? The shaping of energy literacy attributes in UK architecture curricula

Sonja Oliveira¹, Elena Marco² *, Bill Gething²

1. Department of Architecture and the Built Environment, Faculty of Environment and Technology, University of the West of England, Bristol, BS16 1QY, UK
2. Department of Architecture and the Built Environment, Faculty of Environment and Technology, University of the West of England, Bristol, BS16 1QY, UK

Abstract: This paper examines how energy related learning is shaped in undergraduate architectural education in the UK in order to provide novel insights into key energy literacy attributes. Although industry and governmental initiatives highlight the need to retrain building professionals in order to contribute to a sustainable economy, the educational sector has largely overlooked examining literacy dimensions concerning energy in architectural curriculum. While architectural curricula are required to embed sustainable development concerns, it is less clear how energy considerations are met. A qualitative approach drawing on multiple data sources is used to understand the ways accredited architectural educational providers in the UK discuss energy related content in the context of the broader programme specifications, aims of the course, learning outcomes and assessment methods. Drawing on emerging research on energy literacy in other educational settings as well as scholarship on education for sustainable development in architecture, preliminary findings demonstrate a varied and at times conflicting set of approaches. Emphasis is placed on modes of energy content delivery, types of ‘integrated practice’ across energy related curricula, the interface between design studio and technology modules and the role of educators, practitioners and validators. The contribution of the research is to extend current understandings into energy education in the architectural context and build new insights into energy literacy attributes. The findings enable the provision of recommendations that will help define the graduate competencies required of future professionals in a fast developing national and international energy agenda. The analysis has significance for UK education policy in the delivery of architectural curricula as well as the wider built environment educational spectrum including construction management, engineering, building surveying and planning courses.

Key words: energy literacy, architectural education, curriculum design, learning outcomes, learning assessment

1 Introduction

Recent UK governmental and policy reports highlight the need for a skilled and ‘energy literate’ construction industry. The 2011 UK HM government report on “Skills for a Green Economy” outlines the need for diverse sectors to provide recommendations for required strategic skills to ‘enable a transition to a sustainable economy’ [1]. Within the report, the construction sector is seen to call for “architects to incorporate new products/ innovations in design, interpret and take account of new regulations and design for predicted climatic change impacts” [1:19]. An end of term report by the Zero Carbon Hub† similarly calls for an energy literate construction industry that would contribute to a fast developing energy agenda [2]. The higher

* Corresponding author at: Department of Architecture and the Built Environment, Faculty of Environment and Technology, University of the West of England, BS16 1QY
E-mail address: Sonja.Dragojlovic-Oliveira@uwe.ac.uk

† “The Zero Carbon Hub was established in 2008, as a non-profit organisation, to take day-to-day operational responsibility for achieving the government’s target of delivering zero carbon homes in England from 2016”
education sector is tasked with equipping future graduates with the required skills and competencies. Yet, discussions in educational research and professional body documentation largely remain silent on some central aspects regarding the delivery, learning and assessment dimensions concerning energy in architectural curricula. Also while reports within industry and policy often call for ‘energy literacy’, a dearth of research has examined the attributes that define it in the context of architectural education in the UK. Instead, most discussions emphasize the need to retrain, upskill and inform on issues such as “awareness of building performance issues, carbon emissions and energy modelling” [2:20].

More widely in the context of US educational policy discussions, there have been efforts to define energy literacy attributes. The US Department for Energy defines energy literacy in the context of elementary education as ‘an understanding of the nature and role of energy in the universe’ [3]. Energy literacy has also been described in the context of secondary school education in the US as constituted of cognitive (knowledge, understanding, skills); affective (sensitivity, attitudes) and behaviour (activities) dimensions [4]. Recent work by de Waters and Powers [5, 6] contributes by identifying some of the ways by which energy literacy could be evaluated through critique of current assessment methods that “do not reflect energy literacy but rather student achievements with respect to predetermined specific energy related content” [7:1700]. However, their empirical setting involves secondary school students in the US and though valuable does not fully reflect upon the sort of parameters required of university students in the construction sector for instance.

Architectural education in the UK is monitored and validated by its professional bodies. Professional bodies such as Royal Institute of British Architects/Architectural Registration Board (RIBA/ARB) base criteria for validation and prescription of Part 1/2 qualifications on the requirements of article 46 of the EU Qualifications Directive as well as the Quality Assurance Agency Subject Benchmark Statement [8, 9]. The syllabus covers 5 themes including design, communication, technology and environment, cultural context and management, practice and law with specific focus on developing students’ awareness, knowledge and abilities [10]. Prescription/Validation criteria include specific learning outcomes across the themes. Energy issues are not prominent, however, broad aspects relating to “understanding of environmental strategy” (GC.1.2), “the needs and aspirations of building users” (GC. 5), “the impact of buildings on the environment and the precepts of sustainable design” (GC.5), “environmental impact of specification choices” (GC.8.3) and the “principles of designing optimum visual, thermal and acoustic environments” (GC.9) are outlined across graduate attribute criteria.

The purpose of this paper is to examine how architectural educational institutions in the UK account for energy content in their curricula in order to reflect upon some of the likely energy literacy dimensions related to teaching, learning and assessment practices. The following sections discuss relevant literatures on defining literacy attributes more broadly as well as recent empirical studies on energy literacy. Following on the research method is outlined, followed by the findings section, discussion and conclusion.

2 Literature review

Rocap [11:64] defines literacies as a “range of practices, institutions, events artefacts and socially defined and valued competencies that come to be associated with dominant uses of the term”. In traditional discipline-based fields, literacy is typically studied with the primary aim of defining proficiency. However, as issues in energy, sustainability and technology permeate global social and economic agendas, recent debates question the applicability of established measurement criteria. Comber and Nixon [12:223] call for research that enables deeper socio-cultural understandings of literacy specifically as “increasing governments are attempting to contain it and limit it”. Despite wider recognition that literacy practices specifically related to energy and sustainability are increasingly situated within and shaped by both local and
global trends as well as diverse cultural and political contexts [5], few studies have examined their shaping from a socially situated perspective.

Recent work by de Waters and Powers [4, 7] focuses on defining measurement criteria for establishing levels of energy literacy amongst secondary school students in the US. In defining initial scales by which to survey energy literacy de Waters and Powers [4] build upon work carried out in the field of technology and environmental science. Their study draws on technological and environmental literacies to encompass three dimensions of an energy literacy scale based on - cognitive (knowledge, understanding, skills); affective (sensitivity, attitudes) and behaviour (activities) dimensions. The methodological approach undertaken by De Waters and Powers [4] is grounded in quantitative data collection and analysis techniques whereby measurement criteria are validated by a panel of experts and consequently measured in surveys. The survey devised by De Waters et al [6] has recently been applied in a sample of 2400 secondary students involved in a national energy education program in Taiwan by Lee et al [13] showing potential wider applicability. Their research contributes by identifying some of the ways by which energy literacy could be evaluated, however, their empirical setting involves secondary school students and though valuable does not fully reflect upon the sort of social, cultural and pedagogical requirements required of university students in the construction sector.

Research in the built environment domain has largely not examined aspects related to energy literacy. However, an emerging research agenda investigates features related to environmental and or sustainability literacy and sustainability education approaches that are helpful to draw on for this study. Discussions emphasise two aspects relating to environmental literacy and sustainability education: barriers to curriculum integration [14-16] and guidance on how to achieve integration [17-19]. Research that focuses on incorporating sustainability concerns into built environment education outline limitations and opportunities to successful integration. Pan et al [16] argue barriers to successful implementation of sustainability concerns are found in conflicting approaches to research versus teaching amongst students, lecturers and the institution. Cotgrave and Alkhaddar [15] also outline barriers to achieving environmental literacy in the construction education sector. Limitations are described as being contained within the nature and structure of higher education in the UK in areas such as academic indifference and approaches to teaching, lack of communication between industry and academia and lack of student engagement. Altomonte et al [14] suggest deficiencies lie at a European level in university architectural education structural curriculum set ups. They explore the outcomes of a European project ‘Environmental Design in University Curricula and Architectural Training in Europe (EDUCATE), suggesting barriers to implementing sustainability in architectural education lie in educational policy and organizational barriers at a strategic European level.

A number of scholars have begun to articulate some of the ways sustainability could be better integrated into curricula as well as the competencies that encompass sustainability literacy in the built environment. Murray and Cotgrave [19] demonstrate the rationale for systematically embedding sustainability within the construction curriculum to the benefit of professionals, professional bodies and educators. Other scholars look at proposing specific methodologies that integrate real-life projects or energy monitoring systems into curricula. Alahmad et al [17] propose a variety of methods to integrate sustainability into engineering curricula using the architectural engineering (AE) program at the University of Nebraska—Lincoln (UNL) as a case study.

However, few studies have examined empirically or theoretically how educators view learning, teaching and assessment on a relevant and important topic such as energy issues in buildings. Although scholarship and policy have stressed the importance of gaining ‘literacy’ on the topic, discussions have largely overlooked defining and clarifying the attributes that shape energy literacy. Instead, most discussions as reviewed above highlight barriers to integrating sustainability wide issues or propose methods for implementation.
3 Research Method

The research design is based on a multimodal qualitative approach [20] drawing on multiple data sources including documentary evidence and semi-structured interviews. Recent studies on multiple literacies call for qualitative approaches that provide a deeper richer account of literacy dimensions [12]. The approach in this study responds to this wider call drawing on sets of documentary evidence including professional body validation criteria reports, undergraduate architecture course programme specifications, architectural education briefing guides as well as semi-structured interviews with educational providers. Overall 32 documents were used in the analysis. With regards to interviews 25 educational institutions were contacted; to date 9 interviews (30-45min) have taken place with further 10-12 planned in the coming months. Table 1 shows types of data evidence collected and analysed in the period Aug 2014 to Feb 2015.

Table 1 Summary of multiple evidence types collected (Aug 2014-Feb 2015)

<table>
<thead>
<tr>
<th>Types of evidence</th>
<th>Documents</th>
<th>Semi-structured interviews</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Architects Registration Board/ARB (2010) Prescription of qualifications, Criteria at parts 1,2 and 3</td>
<td>Interviews have been carried out with 5 accredited institutions (Cases 9, 21, 23, 24 and 25; 9 participants in total to date)</td>
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<tr>
<td></td>
<td>Centre for Education in the Built Environment/CEBE Briefing Guide Series 11 Problem based learning in architecture</td>
<td></td>
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<tr>
<td></td>
<td>Environmental Design in University Curricula and Architectural Training in Europe/EDUCATE (2012) Sustainable Architectural Education</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Royal Institute of British Architects/RIBA (2011) Validation criteria at part 1 and part 2</td>
<td></td>
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<tr>
<td></td>
<td>Undergraduate architecture programme specifications from institutions named as Case 1- Case 25.</td>
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</tbody>
</table>

The data was collated into a data bank [18] and analysed in NVivo initially using descriptive themes [19]. A theme captures something important about the data in relation to the research question and represents some level of patterned reasoning within the data set [19]. The initial stage of the analysis focused on the identification of codes related to overall course programme aims, learning outcomes and teaching process as well as exploring how energy related content was described. This coding resulted in 40 initial descriptive codes from which 4 key themes were extracted around course aims, course outcomes, course process and energy related content. First order codes were then compared to text segments to understand how these concepts related to similar ideas. Examples of first order codes include ‘pluralist’; ‘integrate’ ‘develop and demonstrate’ and ‘relationships’. As themes started to emerge literatures on design pedagogy, environmental, sustainability and technological literacy were explored.

4 Findings

Preliminary findings suggest that energy related content is rarely referred to in the documentary data (exceptions include cases 4,5,6 and 21), however, broad environmental issues are reflected upon in terms of their consideration to learning outcomes and the overall teaching/learning process. Throughout the data key aspects of learning, teaching and assessing energy-related content are discussed through three main levels.

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‡ Further interviews are currently taking place; what is reported in this study is based on preliminary observations of data collected to date. Future data collection is intended to commence including further semi-structured interviews with educational providers, focus group discussions with students as well as discussion forums with industry practitioners.
of integration: 1) between overall course aims and the environment and technology aspect of the curriculum; 2) between ‘design studio’ staff and ‘technology’ staff; 3) between the expected future role of the architect practitioner, educator and validator (see Table 2).

1) Integration level 1 ‘between overall course aim and environment/technology aspect of curriculum’
Across several cases descriptions related to energy-environmental concerns often revolve around the ‘design agenda’ of the school and its position to technical aspects of the course. One participant initially conveyed a successfully integrated course, describing energy-related content as central to research but not a big design driven.

“Well, it’s very central in terms of our research and obviously that does filter down into our teaching…It's not a big driver in terms of the design agenda and to be brutally honest, I think it's considered as an add-in when it comes to design agenda in the school (Case 24).

Similarly in Case 4 architectural learning related to the environment and energy is described as mediation between the individual and others.

“…A working theory of architecture explored is the reflective practice of making tangible, thoughtful, inhabited places that mediate between the individual, the world and others…” (Case 4)

A number of participants discussed curriculum changes over time and a sense of losing “a very explicit thread of thinking things through sustainably” (Case 21). The syllabus overall is described as containing the required energy-related content; however there seems an overall uncertainty to knowing how it is actually delivered. The data also suggests a strong placement of design studio teaching at the core of the curriculum.

Table 2 Levels of perceived ‘integration’ across curriculum teaching, learning and assessment practices

<table>
<thead>
<tr>
<th>Key themes</th>
<th>Theme characteristics</th>
<th>Example quote</th>
<th>Evidence type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration level 1</td>
<td>Between course aims and energy-related content</td>
<td>Research and design agenda</td>
<td>“Well, it’s very central in terms of our research and obviously that does filter down into our teaching…It's not a big driver in terms of the design agenda (Case 24).”</td>
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<tr>
<td></td>
<td></td>
<td>The individual and others</td>
<td>“…A working theory of architecture…that mediates between the individual, the world and others…” (Case 4)</td>
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<td></td>
<td></td>
<td>The design studio and the modules</td>
<td>“…I think it’s within studio that they’re getting their understanding of sustainability issues” (Case 21).</td>
</tr>
<tr>
<td>Integration level 2</td>
<td>Between design studio and technology staff</td>
<td>Building physics and architectural backgrounds</td>
<td>“Connections between subject discipline and the professional environment” (Case 11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design work and ‘other’ academic work</td>
<td>“To introduce specialist knowledge in technology and environment and how these inform architectural design” (Case 4)</td>
</tr>
<tr>
<td>Integration level 3</td>
<td>Between educator, practitioner and validator roles</td>
<td>Architect educator, practitioner and validator roles</td>
<td>“There is an overregulated programme…also resistance from staff, particularly those based in practice who are just doing what they do…” (Case 9)</td>
</tr>
</tbody>
</table>

One of the participants discussed how teaching environmental and energy related issues were ‘better’ absorbed within the studio although they were taught in separate environment/technology related modules.
"I would say their understanding of sustainability comes from studio - all these different architectural students take studio - so they all take the technology, which I am delivering within studio, but that's probably the…speaking slightly in ignorance, but I think it's within studio that they're getting their understanding of sustainability issues, not in the other modules" (Case 21).

Participants often conveyed a need to improve current practices and ensure better delivery discussing how energy related content is mainly taught through lectures and the expectation is for students to transfer this knowledge in the design studio. Students' understanding in respect of environmental concerns is described as ‘abilities to integrate’ and ‘relate’ specific technological solutions, strategies and responses to “human wellbeing the welfare of future generations the natural world” (Case 13). Students' understanding is seen as being “responsive to a broad and divergent constituency of interests and to the social and emergent ethical concerns related to a brief” with awareness viewed through abilities of “producing a design which integrates complex climate, service and energy supply systems (Case 19)).

2) Integration level 2 between design studio staff and technology staff
Most of the participants described environmental-related content as the domain of “people who have a building physics background, rather than an architectural background” (Case 24). Some participants conveyed a sense of physical separation between technical and non-technical staff viewing integration between environmental based modules and the design studio staff as requiring better ‘physical’ linkages:

“I really wanted to integrate the construction thinking into a housing project and we used to do that by getting the technical staff, literally, to show their face in the studio” (Case 21)

For many the issue of a non-architectural background for environment module staff leaders meant that students found the coursework as a distraction and “not particularly relevant” to the creative design studio part of the course. Participants also discussed the difficulties of allocating sufficient time and finding “time for the students to be able to think about design in creative terms and putting lots and lots of energy aspects into it means that their time becomes very restricted “(Case 24). Students were found to respond to “an energy issue through their design work” whereas when particular ‘technically based’ staff “set them a more academic assignment, I think they sometimes they see it more as a box ticking exercise, they've got to do it, so you're not being creative in helping their design project” (Case 23). Also future students are seen as not being “treated fairly”, entering an industry that is tasked with delivering nearly-zero carbon buildings and not having the competencies or skills needed (Case 9).

3) Integration level 3 between the expected role of the architect-practitioner, the architect-educator and the architect-validator
Most participants discussed the importance of the architects’ future role and the need for developing analytical and technological based skills. Tools (related to energy simulation) are seen as “becoming so much more user friendly…and part of the normal architectural skills”. The role of the architect is also seen as changing to encompass “people doing the calculations”. Architects are seen as not needing to “do the structural calculations, but…needing to have an idea of whether the person who's doing the calculations is actually in the right order of a magnitude, or doing the right thing”. Particular traditionally engineer assumed roles are seen as increasingly accessible to architects due to advances in technology and increasingly user-friendly design tools. In addition to changing roles of future architects, a number of discussions emphasise the changing role of architect-validators. One of the participants described how a more ambitious energy-related course would be faced with difficulties due to “an overregulated programme…resistance from staff, particularly those based in practice who are just doing what they do..” as well as RIBA validators who tend to view ‘energy related content’ as fairly unimportant (Case 9).
Discussion and conclusion

The findings in this study have provided preliminary insights into ways energy-related concerns are included in undergraduate architectural education in the UK. The initial analysis has demonstrated that energy related issues are situated within broader technological, environmental concerns and primarily discussed through ‘awareness’ and ‘understanding’ attributes across 3 levels of integration within the curriculum. In particular discussions emphasise conflicting aspects of integrating ‘technological’ knowledge delivered within modules by ‘technical’ staff into design studio teaching administered by ‘design’ staff. In addition the role of future architects is considered in relation to technological developments in software, changing conceptions of traditionally assumed engineering activities as well as the effects of course design-focused setting agendas. The UK professional syllabus focuses on learning outcomes related to developing students’ awareness, knowledge and abilities across 5 themes [10]; attributes derived from Bloom’s taxonomy of educational objectives within the cognitive domain [21]. The attributes are largely accepted and rarely examined in detail specifically related to skills required to ‘integrate’ particular issues such as energy (seen as a separate syllabus theme).

Recent work by Bachman and Bachman [22] examines the rationale for how learning objectives are designed in architectural education in the US. Their study discusses the global need for clearer definitions of learning outcomes across the curriculum as they would enable better defined ‘sustainable’ feedback practices. Their study suggests learning outcomes in the context of architectural education can be seen as “a common language for describing what curricula are aiming at”. The Associate Collegiate Schools of Architecture (ASCA) recently redefined the programme values and course objectives in architectural education in the US as: Design, Leadership, Stewardship and Critical thinking placing greater emphasis on operationalising feedback practices and making explicit the goals and learning outcomes of a course, including energy-related content.

Despite growing concerns regarding the content and mode of delivery regarding UK architectural education overall and sustainability concerns specifically [23], few studies have examined the ways educational attributes have been interpreted. In addition, a dearth of research has analysed how particular areas of the syllabus such as energy have been included. Detailed analysis of both how skills, knowledge, abilities and awareness have been interpreted in architectural education regarding energy content as well as a wider consideration of the relevance of these attributes to the shaping of energy literacy needs to be undertaken. Future work could examine views and concerns from students as well as take account of industry practitioners’ perspectives. Also, further research could delve deeper into specific subject areas and module specifications. Although the study has focused on undergraduate architectural education in the UK, there are implications for the wider built environment domain and policy on energy literacy more broadly. The findings reported in this study reflect upon some significant perceptions and understandings of energy in architectural education in the UK. Further work is required to enable novel insights into analytically grounded recommendations for ‘energy literacy’ in education as well as practice across the built environment domain.

References


9. ARB, *Final Draft of criteria, parts 1, 2 and 3*, 2010.


