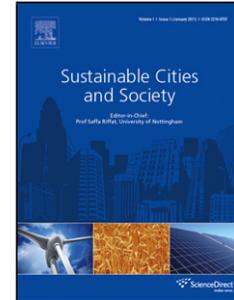# Journal Pre-proof

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Critical learning for sustainable architecture: opportunities for design studio pedagogy

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Highlights

- Implicit values of the design studio undermine critical sustainability.

- Learning for sustainable design must be grounded in existing experiences.

- Pedagogy should focus on critical learning through the design process

- Recommendations to design educators are proposed.

Abstract

Embedding sustainability within building design programmes should be of primary concern for educators. This research identifies opportunities to enhance learning for sustainability within a design studio pedagogy. The design studio is the primary means of educating architects in Europe, however, integrating holistic and critical approaches to sustainability is often neglected. The research adopted a qualitative approach in which a leading RIBA Part 2 architecture programme in the UK was chosen as a case study. Prolonged engagement revealed underlying pedagogic barriers and opportunities for sustainability integration. The research was conducted over two years, sampling two consecutive cohorts of students. Data were collected through interviews with staff and students, observations of teaching practices and analysis of course documents. The findings show that although students

exhibited motivation for sustainability, implicit architectural values undermined holistic

approaches to sustainability. However, the studio presented opportunities to overcome

these barriers including: mainstreaming sustainability within assignments; embracing critical

pedagogies; grounding learning in existing experiences; and focussing on the process of

design. The research has significance for all design led pedagogies. It provides transferable

recommendations to design educators as well as providing insights for the wider profession

to enhance sustainable practice.

Keywords

 Sustainable architecture; Design studio; Sustainable pedagogy; Deep learning.

1 Introduction

Faced with contemporary challenges of environmental degradation, economic instability

and social integration, it is imperative that architects are adequately equipped to meet

these issues. As the primary means of educating architects, the design studio, and its

associated pedagogy, should enable meaningful learning for sustainable design. The design

studio can increase critical engagement and awareness, encouraging acceptance that

sustainability is a contestable and value led concept (Gürel, 2010). Despite its potential for

transdisciplinary learning (Khan, Vandevyvere, & Allacker, 2013), these opportunities for

critical learning in the design studio are rarely exploited by educators. Student engagement

in sustainable themes is often poor (Clune, 2014).This research aims to examine

opportunities for integrating sustainable design into the architectural design studio through

an *instrumental* case study (Stake, 1995). It has two objectives:

1. To describe the current state of sustainable design integration into an

    architectural design studio.

2. To reveal opportunities to enhance deep and critical learning for sustainable

design in an architectural design studio.

The research uses the context of a RIBA Part 2 design studio architecture course in the

UK. The focus on a single architecture programme allowed deep access to reveal underlying

pedagogic structures. The design studio refers to a pedagogy, event and an environment

(McClean, 2009). Not only does it provide a physical space for students work and cohabit, it

describes a pedagogy which is centred around solving particular architectural problems

through the application of tools and knowledge (Gelernter, 1988) facilitated by extended

teaching interactions (Shaffer, 2003). This research considers how the design studio and its

associated pedagogy may encourage deep and critical learning for sustainable design.

2. Literature review

Mainstreaming sustainability is essential in design education to adapt to contemporary

global challenges and industrial changes (O'Rafferty, Curtis, & O'Connor, 2014). Sustainable

issues must be embedded in both learning outcomes (Cotgrave & Alkhaddar, 2006) as well

as assignments (Cotgrave & Kokkarinen, 2011). This requires a shared commitment to

prioritise sustainability from both academic staff and students as well as efforts to evolve

the knowledge base of students and educators (EDUCATE, 2012). The Royal Institute of

British Architects' (RIBA) sustainability and ethics report highlights this need to enhance the

understanding of sustainability across teaching staff (RIBA, 2018). However, a number of

scholars have highlighted the reluctance from academic and teaching staff to acquire new

knowledge (Alabaster & Blair, 1996; Cotgrave & Kokkarinen, 2011). Murray and Cotgrave

(2007) suggests that despite the minimal requirements of sustainability in the curriculum

laid down by professional bodies, such as the RIBA and the Architects' Registration Board (ARB), the major hurdle to overcome is from within the architectural profession.

Despite a broad consensus on the need to *green* the curriculum, there is no coherent framework for integration in architectural education (Ismail, Keumala, & Dabdoob, 2017). Wright (2003) identifies a range of approaches in the US and recommends integration with the real world, an emphasis on context and a commitment to understanding of how buildings work. This is echoed by the findings of a broad European study (EDUCATE, 2012) which highlights the need for students to address contemporary design challenges through critical awareness, ethical responsibility and reflective practice.

The connection between sustainable design education and critically reflective practice is widely advocated as it encourages acceptance that sustainability is a contestable and value led concept (Gürel, 2010; Warburton, 2003). Warburton highlights the need for students to critically evaluate sustainable development ideas. In the field of architecture, this is especially necessary due to the plurality of possible design approaches (Guy & Moore, 2007). Deep learning and critical pedagogy are possible educational approaches which can encourage a reflective approach to sustainable design. Deep learning is particularly relevant to educating for sustainability due to its interdisciplinary, interconnected and holistic nature (Buckingham-Hatfield & Evans, 1996). The critical approach implied by deep learning involves challenging underlying values and assumptions. It is a meta-reflective process, in which the deliberate act of questioning action provides deeper understanding. In deep learning, personal student experience forms the basis of analysis in which assumptions are questioned through an iterative process of action and reflection. This is closely related to critical pedagogy (Pettit, 2010) which describes a dialogical relationship between learner and teacher seeking transformative change through questioning (Darder & Baltodano, 2003,

p.15). This approach has been advocated by Crysler (1995) as an alternative to the *transmission* model of architectural education which embraces competing interpretations informed by personal and individual experience. Experiential learning is a similar approach which describes a cycle of reflective and active process through which learners alternately perceive and process knowledge, constantly referring back to their own concrete experiences (Kolb, 1984).

Reflective practice in the design studio is a key theme in the seminal work of Donald Schön in the 1980s. His book *The Design Studio* (1985) built on work in *The Reflective Practitioner* (1984) and describes a number of key concepts at play in the design studio. *Reflection-in-action* describes how professionals conduct the process of design through a constant reflective dialogue during the act of creation. In contrast, *reflection-on-action* occurs after the event and allows space for the practitioner to consider their output. Through experience of the iterative process of design, students absorb knowledge which becomes tacit. Schön's reflective practice is limited in both its description of studio practice and as a normative model of learning for sustainable design. Critics have highlighted how his description of pedagogy undermines the potential for dialogue. Eraut (1994) points out that Schön's version of learning is one of imitation. As an expert teacher demonstrates the design process, transmission of knowledge to the student is mimetic. Architectural education is reduced to the transfer of skills, abilities and professional competencies rather than accepting it is a contested and dynamic field (Webster, 2008). Schön also fails to note the importance of immersion in architectural education. He limits his description of learning to formal encounters between master and student. Webster (2008) suggests informal learning and high motivation is essential to architectural education.

The characteristic richness of the design studio, its ability to foster motivated students and develop strong learning communities should make it an ideal environment to enhance deep learning for sustainability (Clune, 2014). However, the emphasis on independent and "discovery" learning in the studio may make the acquisition of particular values and skills unreliable (Banerjee & Graaff, 1996). Encouraging self-directed learning may even direct attention away from other aspects of the curriculum (Datta, 2007). Oliveira and Marco (2016) observed that student directed briefs often neglected sustainability. Misconceptions regarding sustainability can lead to barriers to implementation (Filho, 2000) and presenting sustainability as a vague and pluralist concept may confound this (Gürel, 2010).

Despite the need for learning outcomes and curriculum design to reflect issues in sustainability current courses are often designed around inputs such as resources and staff expertise (Cotgrave & Alkhaddar, 2006). Integration must be holistic as fragmentation, ad-hoc additions and non-uniformity may prevent meaningful integration (Cotgrave & Alkhaddar, 2006). A common approach is dividing educational practice into "lectures" and the "design studio" (Altomonte, 2009) in which knowledge is first taught and then applied. This has been advocated in engineering education as it provides students with the skills to deal with both *hard* and *soft* problems (Fenner, Ainger, Cruickshank, & Guthrie, 2005). However it does not reflect the non-linear nature learning (Gelernter, 1988) nor the implicit collaborative learning of the design studio (Webster, 2008).

The master-apprentice model, on which the studio was founded, may pose particular problems for developing deep learning for sustainability. Dutton (1987) points towards a powerful "hidden agenda" of the studio that both intentionally and subconsciously legitimises certain types of knowledge and practice. Underpinned by hierarchical social structures and unchallenged assumptions, each design studio or school of architecture

delivers a particular form of architectural and professional agenda. This professional validation, generated by institutionalised power asymmetries, necessarily excludes alternative forms of practice and in turn, validates the profession and promotes *'a series of self-referential and autonomous values'* (Till, 2003). In the search for innovative processes, underlying meaning and challenging assumptions, '*thinking like an architect'* (Weaver, 1997) may prove problematic. Stevens (1995) notes the tendency of architectural education to '*favour the favoured'* that is to preserve the status quo of the profession limiting its social diversity. Placed in the context deep learning, this limits the exposure of students to multiple points of view, reinforcing professional assumptions and behaviours undermining critical understanding (Brookfield, 1997).

There have been a range of attempts to encourage a critical approach to sustainable design in the studio. Interdisciplinary working has been identified as a possible approach to enhancing reflection, requiring collaboration beyond subject boundaries to tackle issues (Jones, Selby, & Sterling, 2010; O'Rafferty et al., 2014; Warburton, 2003). Howlett, Ferreira, and Blomfield (2016) highlight the need for interdisciplinary learning across higher education to enable genuine critical thinking on sustainable development. In architecture, interdisciplinary learning is also highlighted by both Wright (2003) and EDUCATE (2012) in their reviews of US and European architectural education. Fleming (2002) used teams of students to conduct a variety of competitive design challenges finding that this highlighted teamwork, strategy and an understanding of local environments. This shares similarities of the gamification approach of Reinhart, Dogan, Ibarra, and Samuelson (2012) who used an energy simulation game to enhance awareness. Walker and Seymour (2008) used a similar intensive studio approach through a design charette which they found enhanced collaborative learning and interdisciplinary learning to enhance the understanding of

sustainable concepts. They found its flexibility also enhanced the ability of educators to introduce sustainable concepts.

These approaches, however, rely on the formation of independent learning experiences which act to isolate specific issues and stand in contrast to methodologies situated within the design studio. For example, Gulwadi (2009) used reflective journals in the design studio which enhanced the complexity and depth of thought of students required to deal with sustainable concepts in design. Welsh and Murray (2003) explicitly used critical pedagogy, with projects based in a real world context. This not only encouraged students to move beyond discipline specific boundaries but also served to encourage critical reflection. Clune (2014) used an action research approach to form strategies for enhancing sustainability in the design studio. A deep learning framework drawn directly from the literature (Warburton, 2003) informed novel pedagogies to place greater emphasis on the student understanding. The research found that this enhanced contextual responsive design and a move towards developing complex design scenarios. Linking the design studio to contextual problems was also used by Bala (2010) who raised sustainability consciousness through increasing students' awareness of climatic differences across regions by applying the same brief to different sites.

A number of scholars have also focussed on providing the required skills and knowledge to enable sustainable design in the studio. Natanian and Aleksandrowicz (2018) found that providing preliminary training of sustainable design tools as well as enhancing theoretical understanding could inform a more sustainable design processes in the studio. While integrating specific environmental tools, the case studies show limited evidence, however of reflective learning.

These studies raise the question of the capacity of the contemporary design studio to tackle issues of sustainable design. Successes have been achieved through alternative studio models, often on a small scale by interested practitioners. However, it remains unclear how suitable the existing pedagogy of the design studio is to enable a critical understanding of sustainable design, or whether it may be operationalised to do so.

3. Background and context of the research

A leading architecture programme within a UK university was analysed through a qualitative ethnographic approach. It focussed on the final year of an MArch (RIBA Part 2) design studio course allowing deep and prolonged access to students about to enter the architecture profession. The design studio underpinned the curriculum and completed project work formed 70% of the final degree classification. The course explicitly focussed on encouraging students to adopt holistic approaches to get sustainable design. The studio was structured around two design projects: a group masterplanning project in the first semester; and an individual building design project situated with the masterplan in the second semester. These took place in a global city of the student's choice. Each design assignment was open ended and students were free to explore design issues of their own choice. Both projects were themed "sustainable cities" however choice of building type and nature of masterplan intervention was individual.

Tutors were either full time teaching staff (non-research) or external practitioners who taught part-time. Formal student and tutor interactions in the design studio primarily took place in tutorials and *crits*. Tutorials were in-studio sessions normally involving a single student and tutor (on group projects this was a group and one or two tutors). Crits were formal presentations in which students pinned their work up and presented them in front of

a panel of "critics" (normally comprising of tutors and invited external experts). Studio tutors supported the students and in the second half of the year each student was assigned a tutor to guide them through the project.

Sustainability was integrated into the design studio through specialist consultant tutorials, two or three times, per student, per semester. These were based around individual projects and dealt with issues arising specific to each student. Focus varied between large scale sustainability concerns and small scale management of internal environmental conditions.

Learning in the design student was supplemented by additional lectures and satellite modules. There was a ten-week lecture course on sustainability and environmental design in the first year of study consisting of one two-hour lecture per week, independent from the design studio. This course used a range of visiting practitioners and academics to speak on subjects such as bio-diversity, green infrastructure, accessibility, social sustainability and management of internal building environments. No additional sustainable design lectures were offered in the second year of study.

The practice of design was conducted in the design studio mostly through the production of drawings and sketches (mostly being produced digitally) and a range of 3 dimensional models. In crits, the work presented on the walls consisted almost exclusively of traditional architectural drawings, (maps, plans, sections, elevations, visualisations, diagrams etc.) and models were presented on the floor. In tutorials, a similar range of information was presented, although often in a less completed form and on the table-top.

4. Method

4.1 A Case study approach

The research utilised a qualitative approach using direct methods to capture individual points of view. The paper seeks both *richness* (high quality) and *thickness* (quantity) of data (Fusch & Ness, 2017) to provide a detailed accounts of the case-study . In the framework set out by Stake (1995), the case study is considered instrumental (rather than intrinsic or collective). The case study is chosen to provide insight into the integration of sustainability into the design studio, rather than offering specific, intrinsic interest. As Baxter and Jack (2008) suggests, it is used to accomplish something beyond an understanding of the specific situation and sought broader recommendations for practice.

The researcher was not involved in teaching on the course in order to avoid bias. Most data were gathered through formal settings, (scheduled interviews and planned observations). In Gold's typology of participant observer roles (1958) the researcher might be considered an *observer-as-participant* in which the researcher had minimal involvement in the setting and was not a *natural* part of the study group. In all cases the participants were aware of the presence and role of the observer. The openness of the study and knowledge of participants negated the potential ethical implications of a more immersive researcher role. It allowed a broader data set to be gathered, maintained a suitable distance from the subjects and avoided possible ethical issues. Consideration was also given to discretion in interviews, responsibilities to student welfare, preferential treatment and respecting the attitudes of students to remain anonymous.

4.2 Research sample

The research used a voluntary and purposive sample in which participants were selected based on their knowledge and experiences as well as their willingness to participate (Tongco, 2007). In this case, the relatively small population meant willing student and

educators could be targeted for their perspectives on the course. Data collection took place over a two-year period. Final year MArch (RIBA 2) students at the case study university and educators on thec ourse were participants. Students were typically in their sixth year of formal architectural education allowing them a reflective view on their architectural education. They were also most likely to go into architectural practice.

4.3 Data collection and analysis

A voluntary sample of 20 participants within the population (n=92) were interviewed using semi-structured interviews (Patton, 1980). This provided a baseline understanding and informed further data collection and analysis. Six educators (consistently teaching over the two year period) on the course provided supplementary interviews. Observations of crits and tutorials were undertaken by the researcher in a *naturalistic* manner (Lincoln & Guba, 1985). These provided a formal educational encounter which gave data on the students and educators. Observations were noted and categorised in-situ paying particular attention to the theming of discussions taking place as well as the nature of this dialogue. The data collection scheduled is outlined in table 1.

The data were analysed using the seven phase procedure defined by Marshall (2016): organisation of the data; immersion in the data; generating categories and themes; coding the data; interpreting the data; searching for negative cases and alternative understandings; and writing the report. This was a continuous and iterative process which allowed processing of the data over a long time period and enabled a narrowing of the field of inquiry in later study based on initial findings. Initial immersion in the data gave rise to an early set of themes or *domains*. Domains were formed through a synthesis of the relevant theory with the *in vivo* generation of codes from the raw data. The creation of codes and

domains was influenced by my own sensitisation to the relevant literature. This was an iterative process in which codes and domains were reassessed as the data increased. An example of the coding structure is provided in table 2.

This process was facilitated by a software package (NVivo) which allowed data to be coded and categorised. Interview transcripts, field notes, reflections and photographic evidence was imported into the program and coded. Notes and writing took place simultaneously which was then cross referenced with the analysis informing re-coding and categorisation.

The researcher's role of *observer-as-participant* (Gold, 1958) allowed for easy exiting of the field due to the relatively undeveloped relationships and clear understanding of the researcher's place in the study by participants. The openness of the study and knowledge of participants negated the potential ethical implications of a more immersive researcher role. Choosing when to leave the field, however, was less straight forward and is limited by the time scale of the university semesters and time spent in the studio. This was chosen to coincide with the completion of the particular design project.

Writing of the report is an important aspect of the naturalistic research process, and accurate representation of the research situation is essential to achieving *trustworthiness* (Lincoln & Guba, 1985). It is essential that the report *catch and portray* to the reader what it is like to be embedded in the specific case study (Cohen, Manion, & Morrison, 2000). In line with the guidelines set out by Lincoln and Guba (1985), the report writing focussed on the presentation of facts linked to the collected data, anonymised participants and began by over-including data which was then edited (p.365-6). The report writing process occurred in a cycle with the data analysis, allowing categorisation of data, and informed recoding and restructuring of the data.

4.4 Trustworthiness and Bias

Instrumental case study research may not be generalizable (Hellström, Nolan, & Lundh, 2005) however can be made relatable through its descriptive and evaluative strength. Bassey (1981) suggests that through description other practitioners can broaden their knowledge base to enhance decision making. Lincoln and Guba (1985) describe this as *transferability* and can be achieved through providing a thick description of the research allowing another to reach a conclusion about whether a possible transfer, to another context, might be possible (Lincoln & Guba, 1985). This can be read in conjunction with similar studies (Shenton, 2004) to expand the body knowledge and provide a basis for action across a range of contexts. Enhancing rigour of the research and reducing bias is necessary in this case study approach to improve the transferable value of the work. The framework defined by Lincoln and Guba (1985) of *trustworthiness* was used. As well as *transferable* the research must be credible, confirmable, and dependable.

Credibility (equivalent to internal validity) was achieved through two-year prolonged engagement with the environment in order to learn the culture (Lincoln & Guba, 1985). This was enhanced through persistent observation of different scenarios of the case study. This allowed exposure to a wide range of different issues . This was combined with triangulation of data (Oliver-Hoyo & Allen, 2006) through using various direct and indirect means of collection as well as member checks (validating data with participants) provided further credibility and help to achieve a holistic understanding of the design studio (Baxter & Jack, 2008). Shenton (2004) suggests to enhance the reliability of participant response it was made clear to participants that they were able to be frank and open, give them the right to refuse participation and make it clear the research is completely independent.

Accordingly, individual interviews were conducted privately outside of the design studio, fully anonymised and the researcher did not play any role in the assessment of the course.

Confirmability might be made comparable to objectivity in conventional research. Playing a role in the research introduces possible bias through unconscious prejudices and preconceptions. Participants may modify behaviours, misunderstand the questions or miscommunicate ideas in the presence of the researcher. In collected observational data, while the researcher's presence was noted by participants, the accepted power structures of the tutorial, crit and lecture observation mitigated influence. Although, highlighting independence and seeking honesty, the influence of the researcher on participant responses was limited, researcher bias in interviews was anticipated. Methodological triangulation was again used to manage this bias (Fusch & Ness, 2017) through comparing interview data with observations and finished project work. Shenton (2004) suggest that the process of drawing conclusions be made explicit in order for the reader to understand the logical inferences of the researcher Moreover, this helps acknowledge the researcher's agency (Miles & Huberman, 1994). Accordingly, representative data is provided and then discussed to allow understanding of this process.

Dependability refers to what traditionally might be considered reliability. In a naturalistic paradigm, the findings are tied to the participants and specific context and so cannot be repeated. Instead, a description of the research process is provided to allow readers to assess the dependability of the work (Shenton, 2004). Triangulation can provide dependability through the careful cross referencing of results from a variety of sources and collection techniques (Lincoln & Guba, 1985).

5. Results

Four overarching domains emerged from the research which impacted learning for sustainable design in the studio: course and curriculum, the design process, learner independence and teaching values. Within each of these domains, further sub-themes were identified. These are shown in table 3. The themes are then expanded.

5.1 Course and curriculum

Table 4 describes the key themes related to the course and curriculum with representative quotes.

Explicit sustainable theming of the assignment signified its importance. At an urban scale, students used observations of unsustainability as design generators, proposing sustainable agendas which were then addressed through design proposals. For example, one group aimed to make their chosen city carbon neutral by 2030 which informed a range of design decisions and infrastructural choices including enhancing cycle networks, reimagining a car free city and exploring alternative means of food production. In the individual building project, students were also able to integrate sustainable concerns, from initial ideas to detailed designed. For example, one student described how a desire to create sustainable housing on flooded land had led him to develop prototypical floating structures, guiding his design process. He then drew from his own technical knowledge of building physics to inform the design of these structures.

Design studio teaching was supplemented by lectures on sustainable design. However, there was little evidence of the taught content from lectures manifesting itself in design projects. Lectures were considered valuable by students as providing "core" knowledge to adequately integrate sustainable design holistically into design projects. In the studio, however, sustainable strategies were specific to projects and individually researched. One

student highlighted the abstraction of lectures and its seeming irrelevance to design studio work while another described the "disconnect" between learning in lectures and the studio.

Despite a strong sustainable research agenda in the department, little of this filtered into the design with most researchers having no connection to the course. Tutors were all part-time, non-academic staff who spent most of their time in practice.

5.2 The design process

Table 5 describes the key themes related to the design process with representative quotes. In the case study design studio, the design process was utilised as an educational learning experience. This placed emphasis on tools such as drawing and model making as instruments for reflective practice. Students were required to record their design development in "process documents". Their design process typically involved defining an issue, developing a design "concept" or idea, testing through modelling or sketching, and then accepting, modifying or rejecting these ideas. For example, one group in the masterplanning project identified the issue of disconnected communities, proposed a concept to "stitch" them together and developed a weaving path through sketches that provided a "platform for social interaction".

At an individual project level, design generators were more abstracted. For example, one student used sketches to develop a route which carried the users of the building from light to dark. Sustainable design was conceptualised as a problem-solving activity in order to address issues arisen during the design process. This tended to manifest itself in the application of specific strategies to solve isolated issues that arose during the design process. Often, this involved additive measures that could be overlaid onto completed designs. Learning was often restricted to technical knowledge about particular systems and did not act as a design generator as seen in the masterplanning project. Students spoke of

sustainable design being "put on at the end [of a project]" (Laura), "applied" to the project (Chris) or in some cases in viewed as optional or impossible. Tutors described how they rarely saw sustainability as the underlying generator of design narratives.

Quantitative performance analysis was rare, in part due to the limitations of the representational techniques employed in the studio. This was despite a desire by some students to engage in more quantitative techniques. Others felt the lack of genuine analysis could mask basic or ill-conceived approaches.

The influence of this design process had an impact on the studio environment. There was value placed on design as an iterative process, involving trial and error. This involved the disposal of physical artefacts which were rarely recycled.

5.3 Learner independence

Table 6 describes the key themes related to learner independence with representative quotes.

A number of students demonstrated strong personal motivation for sustainable design. For example, three of the students had undertaken Passivhaus courses in their own time while another had been to a sustainability conference. The freedom of the design studio enabled some students to propose overtly environmental agendas (such as a research centre for climate adaption) and develop knowledge beyond that of their tutors. For others, this freedom allowed them to all but avoid environmental concerns. There was a misalignment between values and action; students would describe how they were concerned about sustainability but this did not impact their studio work. This was noted by tutors who spoke of student's varying levels of engagement with sustainability in their design projects however noted a lack of a fundamental integration.

In many cases the complexity of a design project was seen as a barrier to examining sustainable design themes. One tutor described it a "complex Venn diagram" with sustainability occupying one small section. This open-ended complexity required students to construct their approach based on prior interests, values and assumptions yet not necessarily related to sustainable design. Students and tutors, both described a set of underlying "agendas" for design which were perceived as conflicting with, or undermining, sustainability. One student expressed this tension as the difference between something being "design led" and sustainable (Martha) while another described it as the balance between aesthetics and sustainability (Jane). This dichotomy was echoed by tutors; one spoke of the students who designed with an "architectural aesthetic and visual approach" in which sustainable concerns were secondary (Alan, tutor). Another described other more practical design concerns (such as the location of the front door or the sizes of the rooms) taking precedence (Michael, tutor). Some students perceived a lack of appreciation by both peers and staff for sustainable design.

An exception to this was observed in one student who developed his own sustainable agenda and then structured his individual project around dealing with this issue. This was founded on his own personal experiences of the project site, as well as his existing design knowledge and expertise (he was a Passivhaus designer). This enabled him to develop an architectural response at a building scale that was driven by overtly sustainable concerns.

5.4 Teaching interactions

Table 7 describes the key themes related to teaching interactions with representative quotes.

Students described how Input from tutors had been highly influential on design projects. They spoke of how specific design ideas had originated from their tutor, or how a particular

tutor had directed them to explore a particular theme. For example, one student described how his tutor had encouraged him to depart from the written brief to tackle an issue of local flooding (David).   In some cases, however, students felt their tutor was not interested in sustainable design or "didn't real necessarily talk about it" (Yvonne).

Conversely, tutors described how their teaching was predominantly student led. One tutor spoke of their "psychoanalytical" open ended discussion technique which drove students to make their own decisions (Michael, tutor). Another described how student values governed their approach.

This was reflected in observations of crits in which students chose what work to present which directed the nature of the conversation. For example, in one crit, one of fifteen discussion topics were focussed on sustainability, and in another, only three of twenty. By contrast, in one scheme where the students had developed a particular strong sustainable agenda, eight of the twelve discussion points centred around sustainability concerns. As well as the content of the crit, its format (45 minutes long analysing work pinned up on a wall) led to graphical and verbal presentations which favoured clarity and brevity. Students felt the need to produce "flashy" images (Martha), while others noted the inadequacy of the crit to showcase technical design.

Tutorials typically involved students describing their design ideas followed by idea proposals from tutors. The sustainable design tutor (Alan) often identified problems and offered "solutions", continuously drawing and working through the design. By contrast, *architectural* tutors relied almost entirely on verbal communication however were still observed to raise issues and describe potential solutions. They described their process as one of understanding the student's project and then suggesting ideas that were consistent with their working method. Tailoring approaches in this manner was consistent among all

the tutors. One spoke of how she would bring resources specific to the student (Arlene) while another spoke how it took her time to understand the project in order to offer specific advice (Alison). This specificity was valued by students who described how more generalised learning lacked application to their studio projects.

In the individual project, some group tutorials were conducted, however students exhibited little engagement with the projects of their peers. Indeed, these group "workshops" were abandoned later in the semester in favour of one-to-one interactions due to both student pressure and tutor preference.

6. Discussion

Sustainability integration was most successful when it was made and explicit theme of the design studio through overt description in assignments, supporting the work of Cotgrave and Alkhaddar (2006). However, the scale of design projects also had a major impact on sustainable engagement. Design at the urban scale involved directly addressing an unsustainability challenges. Students were unencumbered by expectations of design and were largely freed from programmatic constraints. This caused them to develop personal agendas which sought to resolve perceived problems. By contrast, the individual building project was governed by underlying values of good design which drove output. This supports the "hidden agenda" described by Dutton (1987), in which students, staff and practitioners defined primary architectural concerns through the development of a tacit, internalised language. "Sustainable design" was often seen to be at odds with "design" and students spoke of the need to balance these two competing concerns. Exceptions to this dichotomy were observed when students formed their own understanding of sustainability and used this to form a personal design narrative which dealt with specific sustainable

agendas. In these cases, students were able to redefine the design expectations and generate alternative realities by placing their own experiences at the centre of their learning in line with a critical pedagogic approach (Crysler, 1995).

The literature on sustainable design advocates interdisciplinary and collaborative working that draws from a range of different backgrounds (Howlett et al., 2016; Jones et al., 2010; Walker & Seymour, 2008). This was evident in the group masterplanning project which enabled peer reflection and discussion of sustainable themes. Despite the social environment of the studio, interaction between peers was far more limited. There was little evidence of *informal creative interactions* (Welsh & Murray, 2003) and students lacked engagements with the projects of their peers in tutorials.

In the case-study, tutorials tended to be discursive rather than the purely transmissive approach described by Schön (1985) corroborating the critique by Webster (2008). In the case-study studio, an interdependent relationship between students and tutors was observed. Tutors responded to student design ideas by proposing improvements which were then adopted by students. This reinforced the embedded values of the design studio and left limited space for holistic, interdisciplinary and critical approaches required for deep learning for sustainability (Buckingham-Hatfield & Evans, 1996). Yet the shadow of Schön, and the power asymmetry of the master and apprentice was apparent in the tendency for tutors to propose solutions technical or architectural solutions. This was particularly true in specific sustainability tutorials in which specialist knowledge was transferred to students in order to solve specific problems. While enhancing technical knowledge, it undermined critical and holistic approaches to sustainable design by emphasising mastery over the shared knowledge creation advocated by Welsh and Murray (2003). Tutors spoke of how they tailored their approach to different student projects, to offer specific design advice, in

some cases, rejecting wider learning that was deemed irrelevant to project work. Tutors were positioned as experts to help enable product creation, rather than facilitate learning. The case-study design studio was taught by practitioners of architecture who themselves were educated in the same system. This embedded an internalised validation system with its own autonomous values (Till, 1996).

In crits there was an emphasis on presentation to aid communicative clarity. For some students, this removed the need for procedural rigour. The visual tools of design, predominantly drawing and model making reflected in crit presentations, were inadequate for quantifying sustainable measures. The emphasis on "discovery" learning through these techniques, did not guarantee the acquisition of specific skills pertaining to sustainable design in accordance with Banerjee and Graaff (1996). This is consistent with the professional practice described by Schön (1985) in which the architect uses design tools, such as drawing and making, to engage in *reflection-in-action*. While these allowed a critique of design conjectures, they were limited in their capacity to encourage deliberate, *reflection-on-action*, a critical skill for deep learning for sustainability (Warburton, 2003).

Crits and tutorials were student-led and discussions surrounding sustainability relied on the nature of the work presented. Although placing students at the centre of the learning process sharing similarities with critical pedagogy (Darder & Baltodano, 2003) and experiential learning (Kolb, 1984). However, this provided no guarantee on the content of critswhich often avoided sustainable design. This corroborates the work of Datta (2007) and Oliveira and Marco (2016) who suggest self-directed learning can exclude sustainability concerns. This lack of engagement in sustainability was partly blamed on the perceived attitudes of critics and tutors, whom many students considered not to value it.

While the need for compliance at a national level (with the RIBA and ARB) ensured the curriculum addressed sustainability concerns, the possibility to extricate these ILOs into satellite units, unrelated to the design studio avoided the need for integration. This supports the assertion by Warburton (2003) who suggests that merely adding content is inadequate for deep learning for sustainability. Dividing lectures and studio is common practice in architecture schools (Altomonte, 2009). This research supports the assertions of however Gelernter (1988) who suggests this approach is ineffective due to the non-sequential nature of learning.

The design studio displayed many of the characteristics consistent with deep learning and critical pedagogy. Students demonstrated a high level of internal motivation for design and were able to reach logical conclusions drawing from their experience as described by Beattie, Collins, and McInnes (1997). The formation of a design proposal demonstrated consistent logical inferences of sustainable knowledge.

Where the studio was less successful was in critically interacting with teaching materials, questioning assumptions and challenging accepted notions of sustainable design (Beattie et al., 1997). The pedagogy of the MArch studio served to develop reflection-in-action (Schön, 1985) and professional competence. However, this limited the ability to address sustainable issues, challenge assumptions and create a wide variety of innovative proposals. Nevertheless, the studio provided space for individual engagement with the four stages of Kolb's learning cycle through individual project led learning (Kolb, 1984), however concrete experiences and abstract conceptualisation was restricted to a narrow sphere of knowledge, rarely based on broader prior experiences. Student process and learning were both consciously bound (through the requirements of assignments) and subliminally influenced (through exposure to a limited range of experiences and perspectives) by the

context of study (Ward, 1990). The design studio had many of the characteristics of a single

loop learning environment (Argyris & Schön, 1974) in which basic assumptions were rarely

challenged.

7. Conclusion and recommendations for educators

The architectural design studio has the potential for developing critical learners for

sustainable design. It encourages independence and intrinsic motivation among students,

characteristics of deep learning processes. The two-year case-study design revealed an

internalised value set which was often perceived as competing with sustainable design. This

agenda acted as the primary barrier to successful integration. However, there are

opportunities for enhancing sustainable design pedagogy by leveraging its existing

strengths. Four recommendations are presented based on the four domains identified in

the findings for the transformation of design studio education. These recommendations

draw from not only the specific findings of the study but are synthesised with the literature

to provide transferable principles which may be applied to a range of studio based

educational contexts.

7.1 Frame assignments as sustainable challenges in real-world contexts

Theming assignments explicitly around sustainable design can highlight the

importance of sustainable design as a mainstream concern in architectural education. This

might be through setting early agendas which set the narrative focus of a project to

addressing issues of unsustainability grounded in real-world contexts. The open-ended

nature of assignments in the design studio provides opportunities for students to create

self-motivated, independent sustainable design frameworks given adequate initial

scaffolding. Focus must move away from the production of building design and towards questioning how architecture can deal with the challenges of sustainability.

7.2 Emphasise the role of the design process in learning

Developing rich and varied learning experiences should be prioritised through emphasising the design process. This involves broadening the range of creative and analytical tools used in the design process and allowing for quantitative or social analysis to be employed to complement traditional architectural competencies. Doing so will encourage critical approaches to sustainability which can be critiqued and evaluated through a range of analytical approaches, beyond the existing traditional media of the studio.

7.3 Ground learning in existing experiences, values and understanding of sustainability

Students were observed to have intrinsic motivation for sustainability and there are opportunities for the studio to support these agendas in the design studio. The design studio may be operationalising the freedom of the studio to encourage the exploration of individual values. The accessibility of architecture also makes wider engagement and collaboration a distinct possibility more challenging in other disciplines. This would enhance critical learning, presenting sustainability as a plural concept and highlights the need for architectural

7.4 Emphasise pedagogy over content

Teaching through specific, standalone tutorials may undermine critical approaches to sustainability and isolate it from culture of architecture. While specialist sustainability knowledge of tutors is valued by students, it should be introduced through critical and reflective interactions between students and educators. Shifting the focus of teaching interactions towards sustainable design can increase its value within the architectural

studio. This might be through formal interventions such as structured discussions in tutorials or through heightening awareness of educators. Encouraging educators to adopt interdisciplinary approaches which span traditional architectural design and sustainability may encourage a shift in values towards more sustainable solutions.

Moving beyond the primary teaching methods of individual tutorials and crit presentations should be examined to enhance deep learning. This might be through introducing alternative learning environments such as seminars or workshops, as well as increasing experiences outside of the design studio. These alternative environments may offer opportunities for enhanced critical analysis of underlying design assumptions. The flexibility of the design studio which is not typically as bound by timetabling constraints as other Higher Education courses provides opportunities for simple integration of these alternative formats.

7.5 Further work

This study has significance for both educators and professional bodies. Educators in all design led subjects should consider how the pedagogy of the design studio may evolve to address sustainable design. The original recommendations presented in this paper are transferable to a range of studio based contexts both within and beyond UK education. Incarnations of the design studio are common in global architectural education and the principles of critical learning may be made transferable to these contexts. Professional bodies (such as the ARB and RIBA) must reconsider the role of required graduate attributes and how these impact design teaching. Supplementary work could expand this study to other architecture programmes to further investigate the phenomenon of sustainability and the design studio and assess transferability to other contexts.

References

Alabaster, T., & Blair, D. (1996). Greening the University. In *Education for Sustainability*. J. Huckle & S. Sterling (Eds.), (86). Oxford: Earthscan.

Altomonte, S. (2009). Environmental education for sustainable architecture. *Review of European Studies. 1*, 12.

Argyris, C., & Schön, D. A. (1974). *Theory in practice: Increasing professional effectiveness*. Jossey-Bass.

Bala, H. A. (2010). Sustainability in the Architectural Design Studio: A Case Study of Designing On-Campus Academic Staff Housing in Konya and Izmir, Turkey. *International Journal of Art & Design Education. 29*, 330-348. DOI:10.1111/j.1476-8070.2010.01665.x

Banerjee, H., & Graaff, E. D. (1996). Problem-based learning in architecture: Problems of integration of technical disciplines. *European Journal of Engineering Education. 21*, 185-195.

Bassey, M. (1981). Pedagogic Research: on the relative merits of search for generalisation and study of single events. *Oxford Review of Education. 7*, 73-94. DOI:10.1080/0305498810070108

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report. 13*, 544-559.

Beattie, I., Vivien, Collins, B., & McInnes, B. (1997). Deep and surface learning: a simple or simplistic dichotomy? *Accounting Education. 6*, 1-12.

Brookfield, S. D. (1997). Assessing Critical Thinking. *New Directions for Adult and Continuing Education. 1997*, 17-29. DOI:10.1002/ace.7502

Buckingham-Hatfield, S., & Evans, R. (1996). *Sustainability and planning*.   Chichester: John Wiley and Sons.

Clune, S. (2014). Design for sustainability and the design studio. *Fusion Journal. 3*, 1-16.

Cohen, L., Manion, L., & Morrison, K. (2000). Research Methods in Education [5 th edn] London: Routledge Falmer. *Teaching in Higher Education. 41*.

Cotgrave, A., & Alkhaddar, R. (2006). Greening the Curricula within Construction Programmes. *Journal for Education in the Built Environment. 1*, 3-29. DOI:10.11120/jebe.2006.01010003

Cotgrave, A. J., & Kokkarinen, N. (2011). Promoting sustainability literacy in construction students: implementation and testing of a curriculum design model. *Structural Survey. 29*, 197-212.

Crysler, C. G. (1995). Critical Pedagogy and Architectural Education. *Journal of Architectural Education (1984-). 48*, 208-217. DOI:10.2307/1425383

Darder, A., & Baltodano, M. (2003). *The critical pedagogy reader*. Psychology Press.

Datta, A. (2007). Gender and Learning in the Design Studio. *Journal for Education in the Built Environment. 2*, 21-35. DOI:10.11120/jebe.2007.02020021

Dutton, T. A. (1987). Design and Studio Pedagogy. *Journal of Architectural Education (1984-). 41*, 16-25. DOI:10.2307/1424904

EDUCATE. (2012). Sustainable Architectural Education: White Paper. Retrieved from Nottingham: https://www.educate-sustainability.eu/kb/

Eraut, M. (1994). *Developing professional knowledge and competence*.   London: London : Falmer.

Fenner, R., A. , Ainger, C., M., Cruickshank, H., J., & Guthrie, P., M. (2005). Embedding sustainable development at Cambridge University Engineering Department. *International Journal of Sustainability in Higher Education. 6*, 229-241. DOI:10.1108/14676370510607205

Filho, W. L. (2000). Dealing with misconceptions on the concept of sustainability. *International Journal of Sustainability in Higher Education. 1*, 9-19. DOI:10.1108/1467630010307066

Fleming, R. (2002). Survivor Studio@ Philadelphia University: promoting sustainability in the design studio through collaborative game playing. *International Journal of Sustainability in Higher Education. 3*, 146-154.

Fusch, G. E., & Ness, L. R. (2017). How to conduct a mini-ethnographic case study: A guide for novice researchers. *The qualitative report. 22*, 923-941.

Gelernter, M. (1988). Reconciling Lectures and Studios. *Journal of Architectural Education. 41*, 46-52. DOI:10.2307/1424834

Gold, R. L. (1958). Roles in sociological field observations. *Social forces* 217-223.

Gulwadi, G. B. (2009). Using reflective journals in a sustainable design studio. *International Journal of Sustainability in Higher Education. 10*, 43-53. DOI:10.1108/14676370910925244

Gürel, M. Ö. (2010). Explorations in Teaching Sustainable Design: A Studio Experience in Interior Design/Architecture. *International Journal of Art & Design Education. 29*, 184-199. DOI:10.1111/j.1476-8070.2010.01649.x

Guy, S., & Moore, S. A. (2007). Sustainable architecture and the pluralist imagination. *Journal of Architectural Education. 60*, 15-23. DOI:10.1111/j.1531-314X.2007.00104.x

Hellström, I., Nolan, M., & Lundh, U. (2005). 'We do things together': A case study of 'couplehood' in dementia. *Dementia. 4*, 7-22. DOI:10.1177/1471301205049188

Howlett, C., Ferreira, J.-A., & Blomfield, J. (2016). Teaching Sustainable Development in Higher Education: Building Critical, Reflective Thinkers through an Interdisciplinary Approach. *International Journal of Sustainability in Higher Education. 17*, 305-321. DOI:10.1108/IJSHE-07-2014-0102

Ismail, M. A., Keumala, N., & Dabdoob, R. M. (2017). Review on integrating sustainability knowledge into architectural education: Practice in the UK and the USA. *Journal of Cleaner Production. 140, Part 3*, 1542-1552. DOI:https://doi.org/10.1016/j.jclepro.2016.09.219

Jones, P., Selby, D., & Sterling, S. R. (2010). More than the Sum of their Parts? Interdisciplinarity and Sustainability. In *Sustainability education: Perspectives and practice across higher education*. P. Jones, D. Selby, & S. R. Sterling (Eds.), (17). Oxford: Earthscan.

Khan, A. Z., Vandevyvere, H., & Allacker, K. (2013). Design for the Ecological Age: Rethinking the Role of Sustainability in Architectural Education. *Journal of Architectural Education. 67*, 175-185. DOI:10.1080/10464883.2013.817155

Kolb, D. A. (1984). Experiental learning. *Englewood Cliffs*.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*.   London: Sage.

Marshall, C. (2016). *Designing qualitative research*. (Sixth edition. ed.) Thousand Oaks, Calif.: SAGE.

McClean, D. 2009. *Embedding learner independence in architecture education: reconsidering design studio pedagogy.* (Doctoral dissertation), Robert Gordon University, Aberdeen.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*.   London: Sage.

Murray, P. E., & Cotgrave, A. J. (2007). Sustainability literacy: the future paradigm for construction education? *Structural Survey. 25*, 7-23. DOI:10.1108/02630800710740949

Natanian, J., & Aleksandrowicz, O. (2018). Environmental Education of an Architect: The case of Final-Year Design Studio at the Technion, Israel. *ArchNet-IJAR: International Journal of Architectural Research. 12*, 356-366.

O'Rafferty, S., Curtis, H., & O'Connor, F. (2014). Mainstreaming sustainability in design education–a capacity building framework. *International Journal of Sustainability in Higher Education. 15*, 169-187.

Oliveira, S., & Marco, E. (2016). Preventing or inventing? Understanding the effects of non-prescriptive design briefs. *International Journal of Technology and Design Education* 1-13.

Oliver-Hoyo, M., & Allen, D. (2006). The Use of Triangulation Methods in Qualitative Educational Research. *Journal of College Science Teaching. 35*, 42-47.

Patton, M. Q. (1980). *Qualitative evaluation methods*. Beverly Hills, Ca: Sage.

Pettit, J. (2010). Multiple faces of power and learning. *IDS Bulletin. 41*, 25-35.

Reinhart, C. F., Dogan, T., Ibarra, D., & Samuelson, H. W. (2012). Learning by playing–teaching energy simulation as a game. *Journal of Building Performance Simulation. 5*, 359-368.

RIBA. (2018). Findings of the RIBA Ethics and Sustainable Development Commission. Retrieved from London: https://www.architecture.com/knowledge-and-resources/resources-landing-page/ribas-ethics-and-sustainable-development-commission-final-report

Schön, D. A. (1984). *The reflective practitioner: How professionals think in action*. New York: Basic books.

Schön, D. A. (1985). *The Design Studio*. London: RIBA Publications Ltd.

Shaffer, D. W. (2003). Portrait of the Oxford Design Studio: An Ethnography of Design Pedagogy. WCER Working Paper No. 2003-11. *Wisconsin Center for Education Research (NJ1)*.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for information. 22*, 63-75.

Stake, R. E. (1995). *The art of case study research*. Sage.

Stevens, G. (1995). Struggle in the studio: A Bourdivin look at architectural pedagogy. *Journal of Architectural Education. 49*, 105-122.

Till, J. (1996). Contingent theory: the educator as ironist. *Stoa. 1*, 66-79.

Till, J. (2003). Lost judgement. *EAAE Prize. 2005*, 164-181.

Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and applications. 5*, 147-158.

Walker, J. B., & Seymour, M. W. (2008). Utilizing the design charrette for teaching sustainability. *International Journal of Sustainability in Higher Education. 9*, 157-169. DOI:10.1108/14676370810856305

Warburton, K. (2003). Deep learning and education for sustainability. *International Journal of Sustainability in Higher Education. 4*, 44-56.

Ward, A. (1990). Ideology, culture and the design studio. *Design Studies. 11*, 10-16. DOI:http://dx.doi.org/10.1016/0142-694X(90)90010-A

Weaver, N. (1997). *The Atelier Principle in Teaching.* Paper presented at the paper delivered at the Conference on Project-Based Learning.

Webster, H. (2008). Architectural Education after Schön: Cracks, Blurs, Boundaries and Beyond. *Journal for Education in the Built Environment. 3*, 63-74.

Welsh, M. A., & Murray, D. L. (2003). The ecollaborative: Teaching sustainability through critical pedagogy. *Journal of Management Education. 27*, 220-235.

Wright, J. (2003). Introducing sustainability into the architecture curriculum in the United States. *International Journal of Sustainability in Higher Education. 4*, 100-105. DOI:10.1108/14676370310467131

Table 1: Data collection *schedule*

Date	Event	Data type
Week 1 Year 1	Head of year interview	Audio recording
Week 4 Year 1	Student interviews	Audio recording
Week 7 Year 1	Student interviews	Audio recording
Week 8 Year 1	Crit observation	Field notes
Week 9 Year 1	Sustainability tutor interview	Audio recording
Week 11 Year 1	Crit Observation	Field notes
Week 18 Year 1	Sustainability lecturer interview	Audio recording
Week 6 Year 2	Tutorial observations	Field notes
Week 8 Year 2	Crit observations	Field notes
Week 9 Year 2	Tutorial observations	Field notes
Week 10 Year 2	Student interviews	Audio recording
Week 11 Year 2	Crit observation	Field notes
Week 16 Year 2	Student interviews	Audio recording
Week 16 Year 2	Final masterplanning design report	Notes
Week 23 Year 2	Sustainability tutorial observation	Field notes
Week 25 Year 2	Sustainability tutorial observation	Field notes
Week 29 Year 2	Crit observation	Field notes
Week 34 Year 2	Final individual design report	Notes

Table 2: Example of coding and domain creation

Domain	Category	Code	Raw data
Teaching interactions	Tutor influence	Combined tutorials valued	"We had a few tutorials with two tutors but not too many where they had different opinions but I think instead of having two tutorials it was better to merge it into one." (Chris, student)
		Exposure to different specialist tutors	"One thing is I would prefer is tutorials with people who have more specialities in that and the same ideas wouldn't just keep happening over again. You look at other projects, they this must plan projects eight years, as the same sort of principles that come up every time. I'm not saying that they should be different but that's to do with the way that you see other years and the way the tutors are the same." (James, student)
		Parallel tutorials valued	"…we always had an environmental report that would go alongside our design and it wouldn't be a last minute thing but we would have environmental tutorials that would go alongside your tutorials so it would usually be quite integrated with that." (Jane, student)

Table 3: Representative quotations and key results

Domain	Themes
Course and curriculum	Assignment theming, disconnect between studio and lectures
The design process	Integrating sustainability into the design process, avoiding sustainable design, the studio environment
Learner independence	Freedom in the studio, student values
Teaching interactions	Tutor influence, student led design

Table 4: Representative quotations and key themes on course and curriculum

Theme	Representative quotes
Assignment theming	*"We are creating a sustainable city. It's in the name so you're almost forced to do it." (Georgina, student)* *"the project we're doing is completely different because it's a masterplan and the project we're doing is a bit different because it's all about sustainability." (Fred, student)*
Disconnect between studio and lectures	*"There is a disconnect between what you learn in lectures and what you actually do in the studio. I don't think I used anything that I learnt in lectures to what I do in my design studios." (Simon, student).* *"It sorts of feels it's taught at [university] like that [adding technologies]. For example if you put a wind turbine on then it works. It doesn't feel like they teach it very well in the respect." (Laura, student)*

Table 5: Representative quotations and key themes on the design process

Theme	Representative quotes
Integrating sustainability into the design process	*"...for example, on the site, where we put the building on that site and that is one of the first considerations of the environmental strategy…then later on you can consider the environmental strategy again as to what sort of technology you can put in your building to make it more sustainable." (Simon, student)* *"In the design studio it's hard. For me sustainability comes out in the Excel spreadsheet really. You can sort of convince in the design studio but really it' s hard to quantify." (Phil, student)*
Avoiding sustainable design	*"I'm not sure whether it's realistic that you do consider the environmental aspect of every project." (Simon, student)* *"if you want to avoid [sustainable design] you can avoid it easily" (Anne, student)*
Studio environment	*"[Design studios] tend not to look like the sort of places where people are concerned with materials. The material is visibly wasted and treated quite badly and not valued and by extension time and resources are squandered in a way in which it doesn't treat those things as valuable." (Michael, tutor)* *"I guess having the materials and things like that are the ones that are readily available, can easily be cut or manipulated and, yeah, no-one really thinks too much about [sustainability] do they?" (Alison, tutor)*

Table 6: Representative quotations and key themes on learner independence

Theme	Representative quotes
Freedom in the design studio	*"This is seen as your opportunity to be free in design and be as creative as you can and if you perceive that as something that hinders creativity or is it another thing that gives you constraints that may help you design something better." (Jane, student)* *"I find students who really have impressive environmental strategies do that in a modest way that isn't necessarily celebrated through the projects and students who do crazy processes of their building type which is far more interesting." (Martha, student).*
Student values	*"[I have sustainable concerns] more outside of architecture…so things like in my household we're quite keen on measuring energy usage and involved in community projects, that kind of stuff." (Martha, student)"* *I know it's very important but when I come to designing something at [university] I don't think about it as much as should because it's not the thing I find the most interesting." (Laura, student)*

Table 7: Representative quotations and key themes on teaching interactions

Theme	Representative quotes
Tutor influence	*"If a tutor has a sustainable agenda then I think that definitely influences the way you work." (Georgina, student)"* *"I had a very good tutor and he said you have this brief, the brief to design a sustainability centre. He said if there is a topic that you really want to tackle you can move away from the brief in order to address the problem if you can justify it." (David, student)*
Student led design	*"I've never been led by a student into discussing their design thinking, in what I would describe in the broadest definition of sustainable ideas." (Michael, tutor)"I can't actually think of many students who've actually used [sustainability] as a generating thing at the beginning of their project" (Richard, tutor)* *"I think it kind of comes from the students really if it's going to be something that's high on their agenda." (Arlene, tutor)* *"It's a balance; [it is not just] advising but it needs to be within what they're interested in. Not just like 'Well that's a load of rubbish, do it like this." (Alison, tutor)*