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# 1 **Critical learning for sustainable architecture: opportunities for design studio pedagogy**

## 2 **Abstract**

3 Embedding sustainability within building design programmes should be of primary concern  
4 for educators. This research identifies opportunities to enhance learning for sustainability  
5 within a design studio pedagogy. The design studio is the primary means of educating  
6 architects in Europe, however, integrating holistic and critical approaches to sustainability is  
7 often neglected. The research adopted a qualitative approach in which a leading RIBA Part  
8 2 architecture programme in the UK was chosen as a case study. Prolonged engagement  
9 revealed underlying pedagogic barriers and opportunities for sustainability integration. The  
10 research was conducted over two years, sampling two consecutive cohorts of students.  
11 Data were collected through interviews with staff and students, observations of teaching  
12 practices and analysis of course documents. The findings show that although students  
13 exhibited motivation for sustainability, implicit architectural values undermined holistic  
14 approaches to sustainability. However, the studio presented opportunities to overcome  
15 these barriers including: mainstreaming sustainability within assignments; embracing critical  
16 pedagogies; grounding learning in existing experiences; and focussing on the process of  
17 design. The research has significance for all design led pedagogies. It provides transferable  
18 recommendations to design educators as well as providing insights for the wider profession  
19 to enhance sustainable practice.

## 20 **Keywords**

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

## 22 **1 Introduction**

23 Faced with contemporary challenges of environmental degradation, economic instability  
24 and social integration, it is imperative that architects are adequately equipped to meet  
25 these issues. As the primary means of educating architects, the design studio, and its  
26 associated pedagogy, should enable meaningful learning for sustainable design. The design  
27 studio can increase critical engagement and awareness, encouraging acceptance that  
28 sustainability is a contestable and value led concept (Gürel, 2010). Despite its potential for  
29 transdisciplinary learning (Khan, Vandevyvere, & Allacker, 2013), these opportunities for  
30 critical learning in the design studio are rarely exploited by educators. Student engagement  
31 in sustainable themes is often poor (Clune, 2014). This research aims to examine  
32 opportunities for integrating sustainable design into the architectural design studio through  
33 an *instrumental* case study (Stake, 1995). It has two objectives:

- 34 1. To describe the current state of sustainable design integration into an  
35 architectural design studio.
- 36 2. To reveal opportunities to enhance deep and critical learning for sustainable  
37 design in an architectural design studio.

38 The research uses the context of a RIBA Part 2 design studio architecture course in the  
39 UK. The focus on a single architecture programme allowed deep access to reveal underlying  
40 pedagogic structures. The design studio refers to a pedagogy, event and an environment  
41 (McClean, 2009). Not only does it provide a physical space for students work and cohabit, it  
42 describes a pedagogy which is centred around solving particular architectural problems  
43 through the application of tools and knowledge (Gelernter, 1988) facilitated by extended  
44 teaching interactions (Shaffer, 2003). This research considers how the design studio and its  
45 associated pedagogy may encourage deep and critical learning for sustainable design.

## 46 2. Literature review

47 Mainstreaming sustainability is essential in design education to adapt to contemporary  
48 global challenges and industrial changes (O'Rafferty, Curtis, & O'Connor, 2014). Sustainable  
49 issues must be embedded in both learning outcomes (Cotgrave & Alkhaddar, 2006) as well  
50 as assignments (Cotgrave & Kokkarinen, 2011). This requires a shared commitment to  
51 prioritise sustainability from both academic staff and students as well as efforts to evolve  
52 the knowledge base of students and educators (EDUCATE, 2012). The Royal Institute of  
53 British Architects' (RIBA) sustainability and ethics report highlights this need to enhance the  
54 understanding of sustainability across teaching staff (RIBA, 2018). However, a number of  
55 scholars have highlighted the reluctance from academic and teaching staff to acquire new  
56 knowledge (Alabaster & Blair, 1996; Cotgrave & Kokkarinen, 2011). Murray and Cotgrave  
57 (2007) suggests that despite the minimal requirements of sustainability in the curriculum  
58 laid down by professional bodies, such as the RIBA and the Architects' Registration Board  
59 (ARB), the major hurdle to overcome is from within the architectural profession.

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

67 The connection between sustainable design education and critically reflective practice  
68 is widely advocated as it encourages acceptance that sustainability is a contestable and  
69 value led concept (Gürel, 2010; Warburton, 2003). Warburton highlights the need for

70 students to critically evaluate sustainable development ideas. In the field of architecture,  
71 this is especially necessary due to the plurality of possible design approaches (Guy & Moore,  
72 2007). Deep learning and critical pedagogy are possible educational approaches which can  
73 encourage a reflective approach to sustainable design. Deep learning is particularly relevant  
74 to educating for sustainability due to its interdisciplinary, interconnected and holistic nature  
75 (Buckingham-Hatfield & Evans, 1996). The critical approach implied by deep learning  
76 involves challenging underlying values and assumptions. It is a meta-reflective process, in  
77 which the deliberate act of questioning action provides deeper understanding. In deep  
78 learning, personal student experience forms the basis of analysis in which assumptions are  
79 questioned through an iterative process of action and reflection. This is closely related to  
80 critical pedagogy (Pettit, 2010) which describes a dialogical relationship between learner  
81 and teacher seeking transformative change through questioning (Darder & Baltodano, 2003,  
82 p.15). This approach has been advocated by Crysler (1995) as an alternative to the  
83 *transmission* model of architectural education which embraces competing interpretations  
84 informed by personal and individual experience. Experiential learning is a similar approach  
85 which describes a cycle of reflective and active process through which learners alternately  
86 perceive and process knowledge, constantly referring back to their own concrete  
87 experiences (Kolb, 1984).

88 Reflective practice in the design studio is a key theme in the seminal work of Donald  
89 Schön in the 1980s. His book *The Design Studio* (1985) built on work in *The Reflective*  
90 *Practitioner* (1984) and describes a number of key concepts at play in the design studio.  
91 *Reflection-in-action* describes how professionals conduct the process of design through a  
92 constant reflective dialogue during the act of creation. In contrast, *reflection-on-action*  
93 occurs after the event and allows space for the practitioner to consider their output.

94 Through experience of the iterative process of design, students absorb knowledge which  
95 becomes tacit. Schön's reflective practice is limited in both its description of studio practice  
96 and as a normative model of learning for sustainable design. Critics have highlighted how  
97 his description of pedagogy undermines the potential for dialogue. Eraut (1994) points out  
98 that Schön's version of learning is one of imitation. As an expert teacher demonstrates the  
99 design process, transmission of knowledge to the student is mimetic. Architectural  
100 education is reduced to the transfer of skills, abilities and professional competencies rather  
101 than accepting it is a contested and dynamic field (Webster, 2008). Schön also fails to note  
102 the importance of immersion in architectural education. He limits his description of learning  
103 to formal encounters between master and student. Webster (2008) suggests informal  
104 learning and high motivation is essential to architectural education.

105 The characteristic richness of the design studio, its ability to foster motivated students  
106 and develop strong learning communities should make it an ideal environment to enhance  
107 deep learning for sustainability (Clune, 2014). However, the emphasis on independent and  
108 "discovery" learning in the studio may make the acquisition of particular values and skills  
109 unreliable (Banerjee & Graaff, 1996). Encouraging self-directed learning may even direct  
110 attention away from other aspects of the curriculum (Datta, 2007). Oliveira and Marco  
111 (2016) observed that student directed briefs often neglected sustainability. Misconceptions  
112 regarding sustainability can lead to barriers to implementation (Filho, 2000) and presenting  
113 sustainability as a vague and pluralist concept may confound this (Gürel, 2010).

114 Despite the need for learning outcomes and curriculum design to reflect issues in  
115 sustainability current courses are often designed around inputs such as resources and staff  
116 expertise (Cotgrave & Alkhaddar, 2006). Integration must be holistic as fragmentation, ad-  
117 hoc additions and non-uniformity may prevent meaningful integration (Cotgrave &

118 Alkhaddar, 2006). A common approach is dividing educational practice into “lectures” and  
119 the “design studio” (Altomonte, 2009) in which knowledge is first taught and then applied.  
120 This has been advocated in engineering education as it provides students with the skills to  
121 deal with both *hard* and *soft* problems (Fenner, Ainger, Cruickshank, & Guthrie, 2005).  
122 However it does not reflect the non-linear nature learning (Gelernter, 1988) nor the implicit  
123 collaborative learning of the design studio (Webster, 2008).

124         The master-apprentice model, on which the studio was founded, may pose particular  
125 problems for developing deep learning for sustainability. Dutton (1987) points towards a  
126 powerful “hidden agenda” of the studio that both intentionally and subconsciously  
127 legitimises certain types of knowledge and practice. Underpinned by hierarchical social  
128 structures and unchallenged assumptions, each design studio or school of architecture  
129 delivers a particular form of architectural and professional agenda. This professional  
130 validation, generated by institutionalised power asymmetries, necessarily excludes  
131 alternative forms of practice and in turn, validates the profession and promotes ‘*a series of*  
132 *self-referential and autonomous values*’ (Till, 2003). In the search for innovative processes,  
133 underlying meaning and challenging assumptions, ‘*thinking like an architect*’ (Weaver, 1997)  
134 may prove problematic. Stevens (1995) notes the tendency of architectural education to  
135 ‘*favour the favoured*’ that is to preserve the status quo of the profession limiting its social  
136 diversity. Placed in the context deep learning, this limits the exposure of students to  
137 multiple points of view, reinforcing professional assumptions and behaviours undermining  
138 critical understanding (Brookfield, 1997).

139         There have been a range of attempts to encourage a critical approach to sustainable  
140 design in the studio. Interdisciplinary working has been identified as a possible approach to  
141 enhancing reflection, requiring collaboration beyond subject boundaries to tackle issues

142 (Jones, Selby, & Sterling, 2010; O'Rafferty et al., 2014; Warburton, 2003). Howlett, Ferreira,  
143 and Blomfield (2016) highlight the need for interdisciplinary learning across higher  
144 education to enable genuine critical thinking on sustainable development. In architecture,  
145 interdisciplinary learning is also highlighted by both Wright (2003) and EDUCATE (2012) in  
146 their reviews of US and European architectural education. Fleming (2002) used teams of  
147 students to conduct a variety of competitive design challenges finding that this highlighted  
148 teamwork, strategy and an understanding of local environments. This shares similarities of  
149 the gamification approach of Reinhart, Dogan, Ibarra, and Samuelson (2012) who used an  
150 energy simulation game to enhance awareness. Walker and Seymour (2008) used a similar  
151 intensive studio approach through a design charette which they found enhanced  
152 collaborative learning and interdisciplinary learning to enhance the understanding of  
153 sustainable concepts. They found its flexibility also enhanced the ability of educators to  
154 introduce sustainable concepts.

155         These approaches, however, rely on the formation of independent learning  
156 experiences which act to isolate specific issues and stand in contrast to methodologies  
157 situated within the design studio. For example, Gulwadi (2009) used reflective journals in  
158 the design studio which enhanced the complexity and depth of thought of students required  
159 to deal with sustainable concepts in design. Welsh and Murray (2003) explicitly used critical  
160 pedagogy, with projects based in a real world context. This not only encouraged students to  
161 move beyond discipline specific boundaries but also served to encourage critical reflection.  
162 Clune (2014) used an action research approach to form strategies for enhancing  
163 sustainability in the design studio. A deep learning framework drawn directly from the  
164 literature (Warburton, 2003) informed novel pedagogies to place greater emphasis on the  
165 student understanding. The research found that this enhanced contextual responsive design

166 and a move towards developing complex design scenarios. Linking the design studio to  
167 contextual problems was also used by Bala (2010) who raised sustainability consciousness  
168 through increasing students' awareness of climatic differences across regions by applying  
169 the same brief to different sites.

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

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

### 181 **3. Background and context of the research**

182 A leading architecture programme within a UK university was analysed through a qualitative  
183 ethnographic approach. It focussed on the final year of an MArch (RIBA Part 2) design  
184 studio course allowing deep and prolonged access to students about to enter the  
185 architecture profession. The design studio underpinned the curriculum and completed  
186 project work formed 70% of the final degree classification. The course explicitly focussed on  
187 encouraging students to adopt holistic approaches to get sustainable design. The studio  
188 was structured around two design projects: a group masterplanning project in the first

189 semester; and an individual building design project situated with the masterplan in the  
190 second semester. These took place in a global city of the student's choice. Each design  
191 assignment was open ended and students were free to explore design issues of their own  
192 choice. Both projects were themed "sustainable cities" however choice of building type and  
193 nature of masterplan intervention was individual.

194 Tutors were either full time teaching staff (non-research) or external practitioners  
195 who taught part-time. Formal student and tutor interactions in the design studio primarily  
196 took place in tutorials and *crits*. Tutorials were in-studio sessions normally involving a single  
197 student and tutor (on group projects this was a group and one or two tutors). Crits were  
198 formal presentations in which students pinned their work up and presented them in front of  
199 a panel of "critics" (normally comprising of tutors and invited external experts). Studio  
200 tutors supported the students and in the second half of the year each student was assigned  
201 a tutor to guide them through the project.

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

207 Learning in the design student was supplemented by additional lectures and satellite  
208 modules. There was a ten-week lecture course on sustainability and environmental design  
209 in the first year of study consisting of one two-hour lecture per week, independent from the  
210 design studio. This course used a range of visiting practitioners and academics to speak on  
211 subjects such as bio-diversity, green infrastructure, accessibility, social sustainability and

212 management of internal building environments. No additional sustainable design lectures  
213 were offered in the second year of study.

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

## 220 **4. Method**

### 221 **4.1 A Case study approach**

222 The research utilised a qualitative approach using direct methods to capture individual  
223 points of view. The paper seeks both *richness* (high quality) and *thickness* (quantity) of data  
224 (Fusch & Ness, 2017) to provide a detailed accounts of the case-study . In the framework  
225 set out by Stake (1995), the case study is considered instrumental (rather than intrinsic or  
226 collective). The case study is chosen to provide insight into the integration of sustainability  
227 into the design studio, rather than offering specific, intrinsic interest. As Baxter and Jack  
228 (2008) suggests, it is used to accomplish something beyond an understanding of the specific  
229 situation and sought broader recommendations for practice.

230 The researcher was not involved in teaching on the course in order to avoid bias.  
231 Most data were gathered through formal settings, (scheduled interviews and planned  
232 observations). In Gold's typology of participant observer roles (1958) the researcher might  
233 be considered an *observer-as-participant* in which the researcher had minimal involvement  
234 in the setting and was not a *natural* part of the study group. In all cases the participants

235 were aware of the presence and role of the observer. The openness of the study and  
236 knowledge of participants negated the potential ethical implications of a more immersive  
237 researcher role. It allowed a broader data set to be gathered, maintained a suitable distance  
238 from the subjects and avoided possible ethical issues. Consideration was also given to  
239 discretion in interviews, responsibilities to student welfare, preferential treatment and  
240 respecting the attitudes of students to remain anonymous.

#### 241 **4.2 Research sample**

242 The research used a voluntary and purposive sample in which participants were selected  
243 based on their knowledge and experiences as well as their willingness to participate  
244 (Tongco, 2007). In this case, the relatively small population meant willing student and  
245 educators could be targeted for their perspectives on the course. Data collection took place  
246 over a two-year period. Final year MArch (RIBA 2) students at the case study university and  
247 educators on the course were participants. Students were typically in their sixth year of  
248 formal architectural education allowing them a reflective view on their architectural  
249 education. They were also most likely to go into architectural practice.

#### 250 **4.3 Data collection and analysis**

251 A voluntary sample of 20 participants within the population (n=92) were interviewed using  
252 semi-structured interviews (Patton, 1980). This provided a baseline understanding and  
253 informed further data collection and analysis. Six educators (consistently teaching over the  
254 two year period) on the course provided supplementary interviews. Observations of crits  
255 and tutorials were undertaken by the researcher in a *naturalistic* manner (Lincoln & Guba,  
256 1985). These provided a formal educational encounter which gave data on the students and  
257 educators. Observations were noted and categorised in-situ paying particular attention to

258 the theming of discussions taking place as well as the nature of this dialogue. The data  
 259 collection scheduled is outlined in table 1.

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

260 *Table 1: Data collection schedule*

261 The data were analysed using the seven phase procedure defined by Marshall (2016):  
 262 organisation of the data; immersion in the data; generating categories and themes; coding  
 263 the data; interpreting the data; searching for negative cases and alternative understandings;  
 264 and writing the report. This was a continuous and iterative process which allowed  
 265 processing of the data over a long time period and enabled a narrowing of the field of  
 266 inquiry in later study based on initial findings. Initial immersion in the data gave rise to an  
 267 early set of themes or *domains*. Domains were formed through a synthesis of the relevant  
 268 theory with the *in vivo* generation of codes from the raw data. The creation of codes and  
 269 domains was influenced by my own sensitisation to the relevant literature. This was an  
 270 iterative process in which codes and domains were reassessed as the data increased. An  
 271 example of the coding structure is provided in table 2.

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)

272 Table 2: Example of coding and domain creation

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

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

285 Writing of the report is an important aspect of the naturalistic research process, and  
286 accurate representation of the research situation is essential to achieving *trustworthiness*  
287 (Lincoln & Guba, 1985). It is essential that the report *catch and portray* to the reader what

288 it is like to be embedded in the specific case study (Cohen, Manion, & Morrison, 2000). In  
289 line with the guidelines set out by Lincoln and Guba (1985), the report writing focussed on  
290 the presentation of facts linked to the collected data, anonymised participants and began by  
291 over-including data which was then edited (p.365-6). The report writing process occurred in  
292 a cycle with the data analysis, allowing categorisation of data, and informed recoding and  
293 restructuring of the data.

#### 294 **4.4 Trustworthiness and Bias**

295 Instrumental case study research may not be generalizable (Hellström, Nolan, & Lundh,  
296 2005) however can be made relatable through its descriptive and evaluative strength.  
297 Bassey (1981) suggests that through description other practitioners can broaden their  
298 knowledge base to enhance decision making. Lincoln and Guba (1985) describe this as  
299 *transferability* and can be achieved through providing a thick description of the research  
300 allowing another to reach a conclusion about whether a possible transfer, to another  
301 context, might be possible (Lincoln & Guba, 1985). This can be read in conjunction with  
302 similar studies (Shenton, 2004) to expand the body knowledge and provide a basis for action  
303 across a range of contexts. Enhancing rigour of the research and reducing bias is necessary  
304 in this case study approach to improve the transferable value of the work. The framework  
305 defined by Lincoln and Guba (1985) of *trustworthiness* was used. As well as *transferable* the  
306 research must be credible, confirmable, and dependable.

307 Credibility (equivalent to internal validity) was achieved through two-year prolonged  
308 engagement with the environment in order to learn the culture (Lincoln & Guba, 1985).  
309 This was enhanced through persistent observation of different scenarios of the case study.  
310 This allowed exposure to a wide range of different issues . This was combined with

311 triangulation of data (Oliver-Hoyo & Allen, 2006) through using various direct and indirect  
312 means of collection as well as member checks (validating data with participants) provided  
313 further credibility and help to achieve a holistic understanding of the design studio (Baxter  
314 & Jack, 2008). Shenton (2004) suggests to enhance the reliability of participant response it  
315 was made clear to participants that they were able to be frank and open, give them the  
316 right to refuse participation and make it clear the research is completely independent.  
317 Accordingly, individual interviews were conducted privately outside of the design studio,  
318 fully anonymised and the researcher did not play any role in the assessment of the course.

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

333         Dependability refers to what traditionally might be considered reliability. In a  
334 naturalistic paradigm, the findings are tied to the participants and specific context and so

335 cannot be repeated. Instead, a description of the research process is provided to allow  
 336 readers to assess the dependability of the work (Shenton, 2004). Triangulation can provide  
 337 dependability through the careful cross referencing of results from a variety of sources and  
 338 collection techniques (Lincoln & Guba, 1985).

339 **5. Results**

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

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

344 *Table 3: Representative quotations and key results*

345 **5.1 Course and curriculum**

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

Theme	Representative quotes
<b>Assignment theming</b>	<i>"We are creating a sustainable city. It's in the name so you're almost forced to do it." (Georgina, student)</i> <i>"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)</i>
<b>Disconnect between studio and lectures</b>	<i>"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).</i> <i>"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)</i>

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

349 Explicit sustainable theming of the assignment signified its importance. At an urban scale,  
 350 students used observations of unsustainability as design generators, proposing sustainable

351 agendas which were then addressed through design proposals. For example, one group  
 352 aimed to make their chosen city carbon neutral by 2030 which informed a range of design  
 353 decisions and infrastructural choices including enhancing cycle networks, reimagining a car  
 354 free city and exploring alternative means of food production. In the individual building  
 355 project, students were also able to integrate sustainable concerns, from initial ideas to  
 356 detailed designed. For example, one student described how a desire to create sustainable  
 357 housing on flooded land had led him to develop prototypical floating structures, guiding his  
 358 design process. He then drew from his own technical knowledge of building physics to  
 359 inform the design of these structures.

360 Design studio teaching was supplemented by lectures on sustainable design. However,  
 361 there was little evidence of the taught content from lectures manifesting itself in design  
 362 projects. Lectures were considered valuable by students as providing “core” knowledge to  
 363 adequately integrate sustainable design holistically into design projects. In the studio,  
 364 however, sustainable strategies were specific to projects and individually researched. One  
 365 student highlighted the abstraction of lectures and its seeming irrelevance to design studio  
 366 work while another described the “disconnect” between learning in lectures and the studio.

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

## 370 **5.2 The design process**

371 Table 5 describes the key themes related to the design process with representative quotes.

Theme	Representative quotes
<b>Integrating sustainability into the design process</b>	<i>“...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)</i>

	<i>"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)</i>
<b>Avoiding sustainable design</b>	<i>"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)</i>
<b>Studio environment</b>	<i>"[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)</i>

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

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

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

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

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

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

### 400 **5.3 Learner independence**

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

Theme	Representative quotes
<b>Freedom in the design studio</b>	<p data-bbox="568 1238 1385 1361"><i>“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></p> <p data-bbox="568 1368 1385 1489"><i>“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).</i></p>
<b>Student values</b>	<p data-bbox="568 1496 1385 1592"><i>“[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></p> <p data-bbox="568 1599 1385 1684"><i>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)</i></p>

403 *Table 6: Representative quotations and key themes on learner independence*

404 A number of students demonstrated strong personal motivation for sustainable design. For  
 405 example, three of the students had undertaken Passivhaus courses in their own time while  
 406 another had been to a sustainability conference. The freedom of the design studio enabled  
 407 some students to propose overtly environmental agendas (such as a research centre for

408 climate adaption) and develop knowledge beyond that of their tutors. For others, this  
409 freedom allowed them to all but avoid environmental concerns. There was a misalignment  
410 between values and action; students would describe how they were concerned about  
411 sustainability but this did not impact their studio work. This was noted by tutors who spoke  
412 of student's varying levels of engagement with sustainability in their design projects  
413 however noted a lack of a fundamental integration.

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

428 An exception to this was observed in one student who developed his own sustainable  
429 agenda and then structured his individual project around dealing with this issue. This was  
430 founded on his own personal experiences of the project site, as well as his existing design

431 knowledge and expertise (he was a Passivhaus designer). This enabled him to develop an  
 432 architectural response at a building scale that was driven by overtly sustainable concerns.

433 **5.4 Teaching interactions**

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

Theme	Representative quotes
<b>Tutor influence</b>	<p data-bbox="568 613 1382 674"><i>"If a tutor has a sustainable agenda then I think that definitely influences the way you work." (Georgina, student)</i></p> <p data-bbox="568 680 1382 801"><i>"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)</i></p>
<b>Student led design</b>	<p data-bbox="568 808 1382 869"><i>"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></p> <p data-bbox="568 875 1382 965"><i>"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></p> <p data-bbox="568 972 1382 1032"><i>"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)</i></p> <p data-bbox="568 1039 1382 1126"><i>"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)</i></p>

436 *Table 7: Representative quotations and key themes on teaching interactions*

437 Students described how Input from tutors had been highly influential on design projects.  
 438 They spoke of how specific design ideas had originated from their tutor, or how a particular  
 439 tutor had directed them to explore a particular theme. For example, one student described  
 440 how his tutor had encouraged him to depart from the written brief to tackle an issue of local  
 441 flooding (David). In some cases, however, students felt their tutor was not interested in  
 442 sustainable design or "didn't real necessarily talk about it" (Yvonne).

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

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

456 Tutorials typically involved students describing their design ideas followed by idea  
457 proposals from tutors. The sustainable design tutor (Alan) often identified problems and  
458 offered “solutions”, continuously drawing and working through the design. By contrast,  
459 *architectural* tutors relied almost entirely on verbal communication however were still  
460 observed to raise issues and describe potential solutions. They described their process as  
461 one of understanding the student’s project and then suggesting ideas that were consistent  
462 with their working method. Tailoring approaches in this manner was consistent among all  
463 the tutors. One spoke of how she would bring resources specific to the student (Arlene)  
464 while another spoke how it took her time to understand the project in order to offer specific  
465 advice (Alison). This specificity was valued by students who described how more  
466 generalised learning lacked application to their studio projects.

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

## 471 6. Discussion

472 Sustainability integration was most successful when it was made an explicit theme of the  
473 design studio through overt description in assignments, supporting the work of Cotgrave  
474 and Alkhaddar (2006). However, the scale of design projects also had a major impact on  
475 sustainable engagement. Design at the urban scale involved directly addressing an  
476 unsustainability challenges. Students were unencumbered by expectations of design and  
477 were largely freed from programmatic constraints. This caused them to develop personal  
478 agendas which sought to resolve perceived problems. By contrast, the individual building  
479 project was governed by underlying values of good design which drove output. This  
480 supports the “hidden agenda” described by Dutton (1987), in which students, staff and  
481 practitioners defined primary architectural concerns through the development of a tacit,  
482 internalised language. “Sustainable design” was often seen to be at odds with “design” and  
483 students spoke of the need to balance these two competing concerns. Exceptions to this  
484 dichotomy were observed when students formed their own understanding of sustainability  
485 and used this to form a personal design narrative which dealt with specific sustainable  
486 agendas. In these cases, students were able to redefine the design expectations and  
487 generate alternative realities by placing their own experiences at the centre of their learning  
488 in line with a critical pedagogic approach (Crysler, 1995).

489 The literature on sustainable design advocates interdisciplinary and collaborative  
490 working that draws from a range of different backgrounds (Howlett et al., 2016; Jones et al.,  
491 2010; Walker & Seymour, 2008). This was evident in the group masterplanning project  
492 which enabled peer reflection and discussion of sustainable themes. Despite the social  
493 environment of the studio, interaction between peers was far more limited. There was little

494 evidence of *informal creative interactions* (Welsh & Murray, 2003) and students lacked  
495 engagements with the projects of their peers in tutorials.

496 In the case-study, tutorials tended to be discursive rather than the purely transmissive  
497 approach described by Schön (1985) corroborating the critique by Webster (2008). In the  
498 case-study studio, an interdependent relationship between students and tutors was  
499 observed. Tutors responded to student design ideas by proposing improvements which  
500 were then adopted by students. This reinforced the embedded values of the design studio  
501 and left limited space for holistic, interdisciplinary and critical approaches required for deep  
502 learning for sustainability (Buckingham-Hatfield & Evans, 1996). Yet the shadow of Schön,  
503 and the power asymmetry of the master and apprentice was apparent in the tendency for  
504 tutors to propose solutions technical or architectural solutions. This was particularly true in  
505 specific sustainability tutorials in which specialist knowledge was transferred to students in  
506 order to solve specific problems. While enhancing technical knowledge, it undermined  
507 critical and holistic approaches to sustainable design by emphasising mastery over the  
508 shared knowledge creation advocated by Welsh and Murray (2003). Tutors spoke of how  
509 they tailored their approach to different student projects, to offer specific design advice, in  
510 some cases, rejecting wider learning that was deemed irrelevant to project work. Tutors  
511 were positioned as experts to help enable product creation, rather than facilitate learning.  
512 The case-study design studio was taught by practitioners of architecture who themselves  
513 were educated in the same system. This embedded an internalised validation system with  
514 its own autonomous values (Till, 1996).

515 In crits there was an emphasis on presentation to aid communicative clarity. For some  
516 students, this removed the need for procedural rigour. The visual tools of design,  
517 predominantly drawing and model making reflected in crit presentations, were inadequate

518 for quantifying sustainable measures. The emphasis on “discovery” learning through these  
519 techniques, did not guarantee the acquisition of specific skills pertaining to sustainable  
520 design in accordance with Banerjee and Graaff (1996). This is consistent with the  
521 professional practice described by Schön (1985) in which the architect uses design tools,  
522 such as drawing and making, to engage in *reflection-in-action*. While these allowed a  
523 critique of design conjectures, they were limited in their capacity to encourage deliberate,  
524 *reflection-on-action*, a critical skill for deep learning for sustainability (Warburton, 2003).

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

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

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

546 Where the studio was less successful was in critically interacting with teaching  
547 materials, questioning assumptions and challenging accepted notions of sustainable design  
548 (Beattie et al., 1997). The pedagogy of the MArch studio served to develop reflection-in-  
549 action (Schön, 1985) and professional competence. However, this limited the ability to  
550 address sustainable issues, challenge assumptions and create a wide variety of innovative  
551 proposals. Nevertheless, the studio provided space for individual engagement with the four  
552 stages of Kolb's learning cycle through individual project led learning (Kolb, 1984), however  
553 concrete experiences and abstract conceptualisation was restricted to a narrow sphere of  
554 knowledge, rarely based on broader prior experiences. Student process and learning were  
555 both consciously bound (through the requirements of assignments) and subliminally  
556 influenced (through exposure to a limited range of experiences and perspectives) by the  
557 context of study (Ward, 1990). The design studio had many of the characteristics of a single  
558 loop learning environment (Argyris & Schön, 1974) in which basic assumptions were rarely  
559 challenged.

## 560 **7. Conclusion and recommendations for educators**

561 The architectural design studio has the potential for developing critical learners for  
562 sustainable design. It encourages independence and intrinsic motivation among students,  
563 characteristics of deep learning processes. The two-year case-study design revealed an

564 internalised value set which was often perceived as competing with sustainable design. This  
565 agenda acted as the primary barrier to successful integration. However, there are  
566 opportunities for enhancing sustainable design pedagogy by leveraging its existing  
567 strengths. Four recommendations are presented based on the four domains identified in  
568 the findings for the transformation of design studio education. These recommendations  
569 draw from not only the specific findings of the study but are synthesised with the literature  
570 to provide transferable principles which may be applied to a range of studio based  
571 educational contexts.

### 572 ***7.1 Frame assignments as sustainable challenges in real-world contexts***

573 Theming assignments explicitly around sustainable design can highlight the  
574 importance of sustainable design as a mainstream concern in architectural education. This  
575 might be through setting early agendas which set the narrative focus of a project to  
576 addressing issues of unsustainability grounded in real-world contexts. The open-ended  
577 nature of assignments in the design studio provides opportunities for students to create  
578 self-motivated, independent sustainable design frameworks given adequate initial  
579 scaffolding. Focus must move away from the production of building design and towards  
580 questioning how architecture can deal with the challenges of sustainability.

### 581 ***7.2 Emphasise the role of the design process in learning***

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

587 through a range of analytical approaches, beyond the existing traditional media of the  
588 studio.

### 589 ***7.3 Ground learning in existing experiences, values and understanding of sustainability***

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

### 597 ***7.4 Emphasise pedagogy over content***

598 Teaching through specific, standalone tutorials may undermine critical approaches to  
599 sustainability and isolate it from culture of architecture. While specialist sustainability  
600 knowledge of tutors is valued by students, it should be introduced through critical and  
601 reflective interactions between students and educators. Shifting the focus of teaching  
602 interactions towards sustainable design can increase its value within the architectural  
603 studio. This might be through formal interventions such as structured discussions in tutorials  
604 or through heightening awareness of educators. Encouraging educators to adopt  
605 interdisciplinary approaches which span traditional architectural design and sustainability  
606 may encourage a shift in values towards more sustainable solutions.

607 Moving beyond the primary teaching methods of individual tutorials and crit  
608 presentations should be examined to enhance deep learning. This might be through  
609 introducing alternative learning environments such as seminars or workshops, as well as  
610 increasing experiences outside of the design studio. These alternative environments may

611 offer opportunities for enhanced critical analysis of underlying design assumptions. The  
612 flexibility of the design studio which is not typically as bound by timetabling constraints as  
613 other Higher Education courses provides opportunities for simple integration of these  
614 alternative formats.

### 615 **7.5 Further work**

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

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