

ARCHITECTURAL EDUCATION: METHODS FOR INTEGRATING CLIMATE CHANGE DESIGN (CCD) IN THE CURRICULUM

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INTRODUCTION

The design and construction of buildings are responsible for 40% of the EU's energy use with an associated 36% CO₂ emissions,¹ significantly contributing to the climate emergency. Thus, the EU aims for climate neutrality by 2050,² but this needs to be achieved much sooner to avoid exacerbated damage and other related crises and to ensure climate justice.³ However, in architectural education, a significant gap in Climate Change Design (CCD) knowledge, skills and competencies exist for both students and educators and is one of the biggest challenges in the construction industry, as noted by the IPCC.⁴ Over 4000 architects in 18 countries declared 'a biodiversity and climate emergency'⁵ with over 2500 architecture students and teachers globally signing the 'architecture education declares' action with a 'call for a curriculum change'.⁶

This paper, as part of the transnational ARCH4CHANGE EU Erasmus + funded project '*Digital climate change curriculum for architectural education: methods towards carbon neutrality*', presents findings from a systematic literature review, focusing on the barriers and successful pedagogical methods to meet this urgent challenge in architecture education.

Research focus

There is a need for teacher training to upskill teachers in CCD as the typical pedagogical approaches in schools of architecture, their cultures, and employment contracts result in many practitioner educators being employed (with less experience and skill in wider pedagogical theories and methods).⁷ The term CCD is relatively new, and publications mainly refer to 'sustainability; therefore, the term sustainability is used in this paper, as a proxy for CCD. This paper focuses on the educator, rather than the students they teach; to understand barriers and opportunities, skills and attributes needed for CCD,

The need for this enquiry is confirmed by a recent literature review by Boarin and Martinez-Molina,⁸ which explores the integration of sustainability issues in higher education across the globe.

This paper focuses on the "how" rather than the "what" in terms of sustainability integration, with a specific set of research questions. Questioning the architecture educators' role, responsibilities, skills, and attributes, and concentrating on the approaches that successfully integrate CCD into architectural education, rather than evaluating all approaches.

As a result, four research questions are posed, around which the paper is structured:

RQ1: What pedagogies and teaching methods facilitate the successful integration of sustainable design in architectural education?
RQ2: What skills and competencies are needed by educators to integrate [these] sustainable design pedagogies and teaching methods?
RQ3: What are the barriers and challenges for upskilling educators to attain these skills and competencies?
RQ4: How can these barriers be overcome; as related to teacher competencies, <u>skills</u> and knowledge?

Table 1: Research Questions (RQ) 1-4

METHODOLOGY AND LIMITATIONS

In order to identify, interpret and analyse the existing research on the defined research questions, a Systematic Literature Review was conducted. Four main steps were defined to conduct the systematic literature review, (1) commencing with the research questions (RQ1, RQ2, RQ3, and RQ4), following with (2) the definition of keywords and selection of databases, (3) consideration of inclusion and exclusion criteria, and (4) assessment of the quality of the included studies.

Five databases were selected (Art & Architecture Source, Scopus/Elsevier, Jstor, Education collection (ProQuest), Teacher Reference Center (EBSCO), Arts & Humanities Database (ProQuest)) based on their trustworthiness, ability to include a range of sources from journal papers to conference proceedings and their relevance to the research focus.

Keywords were linked with particular research questions and developed into an initial repository of publications, as presented in Tables 1-4. There was no limit to the document type in order to understand as widely as possible. There was also no geographic restriction, including both undergraduate and postgraduate courses. As exclusion criteria, the search was limited to 2005 to present and in the English language as being most representative for most authors publishing in this field, to focus on literature published since the launch of the United Nations Decade of Education for Sustainable Development in 2005⁹ and being more recent, more likely to focus on the “how”, the purpose of this review. From this initial systematic search using the keywords, 87 publications were retrieved. As the sampling was relatively small, no further exclusion of publications was undertaken. However, upon detailed review, 16 were eliminated due to duplication or irrelevance within the document beyond the relevant keyword in the title. The relatively limited number of publications is in line with previous findings, which see the area of sustainability integration specific to architectural education mainly unevaluated.¹⁰ These publications were assigned among the authors, and a review template used which allowed for the input of findings across all research questions, recognising the interconnectedness of the themes. The first author then double-checked the review and the most salient points and synthesized the key findings to develop initial insights, which all authors reviewed and is presented below. RQ3 and RQ4 had the least literature directly related to them due to the student focus in publications.

RQ1: What pedagogies and teaching methods facilitate the successful integration of sustainable design in architectural education?				
Level 1		Level 2		Level 3
Sustain (-able, -ability)	AND	Architect (-ure)	AND	Pedagog (-y, -ies, -ical)
				Design Education
				Design Teaching
				Studio
				Education
				Learning
				Teaching and learning Methods
				Teaching
				Pedagog (-y, -ies, -ical)
Design Education				

Table 2: Keywords for RQ1

RQ2: What skills and competencies are needed by educators to integrate [these] sustainable design pedagogies and teaching methods?				
Level 1		Level 2		Level 3
Sustain(-able,-ability)	AND	Skill(-s)	AND	Design Studio
		Knowledge		Design Education
		Competenc(-y, -ies)		Design Teaching
				Design Learning
Sustain(-able, -ability)	AND	Skill(-s)	AND	Architect (-ure) Studio
		Knowledge		Architect (-ure) Education
		Competenc(-y, -ies)		Architect (-ure)Teaching
				Architect (-ure) Learning

Table 3: Keywords for RQ2

RQ3: What are the barriers and challenges for upskilling educators to attain these skills and competencies?				
Level 1		Level 2		Level 3
Sustain(-able, -ability)	AND	Architect (-ure)	AND	Teaching Experience (-s)
				Teaching Strateg (-y, -ies)
				Teaching Solution (-s)
				Teaching Case Stud (-y, -ies)
				Teaching Approach (-es)
				Teaching Tool (-s)
				Teaching Model (-s)
Sustain(-able, -ability)	AND	Architect (-ure)	AND	Barriers
		Integration		Challenge (-s)
		Architect (-ure) Teaching		Gap (-s)
		Architect (-ure) Design		Limitation (-s)
		Design Education		Upskill (-ing)
		Design Studio		Improv (-e,-ing)
		Design Learning		Didactic (-s)
		Design Teaching		Appraisal (-s)
	Incorporat (-e, -ing)			
	Practic (-e, -ioner) led			

Table 4: Keywords for RQ3

RQ4: How can these barriers be overcome; as related to teacher competencies, <u>skills</u> and knowledge?				
Level 1		Level 2		Level 3
Sustain(-able, -ability)	AND	Architect (-ure) Teach (-er, -ing)	AND	Experience (-s)
				Strateg (-y, -ies)
				Solution (-s)
				Case Stud (-y, -ies)
				Approach (-es)
				Tool (-s)
				Model (-s)
				Virtual practice
				Digital practice
				Opportunity (-y, -ies)
				Experiment (-s)
				Exploration (-s)
				Blended
				New Delivery mode (-s)
New Tool (-s)				
Sustain(-able, -ability)	AND	Design Education	AND	Experience (-s)
		Design Studio		Strateg (-y, -ies)
		Design Learning		Solution (-s)
		Design Teaching		Case Stud (-y, -ies)
				Approach (-es)
				Tool (-s)
				Model (-s)
				Virtual practice
				Digital practice
				Opportunity (-y, -ies)
				Experiment (-s)
				Exploration (-s)
				Blended
				New Delivery mode (-s)
	New Tool (-s)			
	Experiment (-s)			

Table 5: Keywords for RQ4

RESULTS

Firstly, analysis across all papers was undertaken to define 1) the geographic location of the studies (Figure 1).

2) the year of the study (Figure 2); 3) the types of methodologies most typically being used (Figure 3) and 4) whether the document's focus was on students, educators, or both (Figure 4).

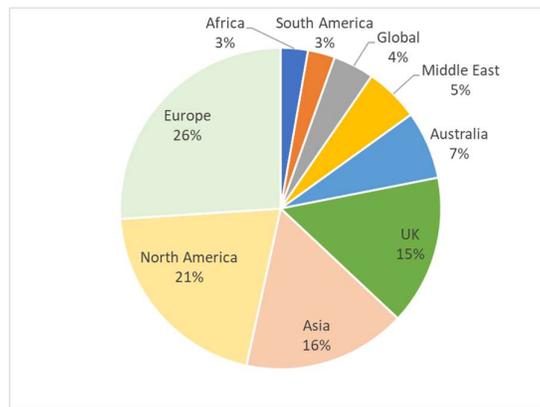


Figure 1: Geographic location of publications: majority in line with Boarin's recent study¹.

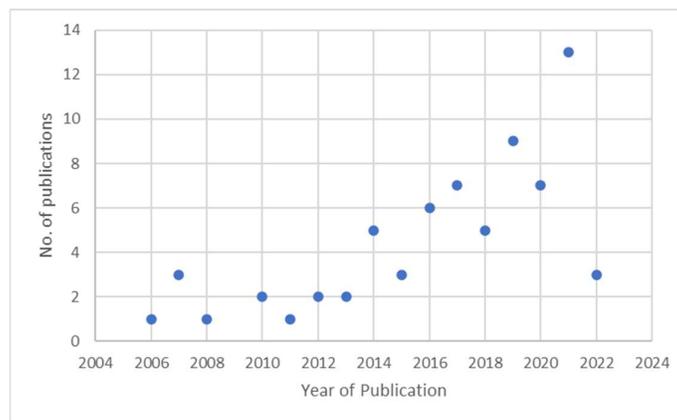


Figure 2: Publishing year of publications for the included publications: number of publications increasing year on year, reflecting the growing urgency of the topic the keywords identified.

(Note only the first quarter of 2022 was included at the time of writing).

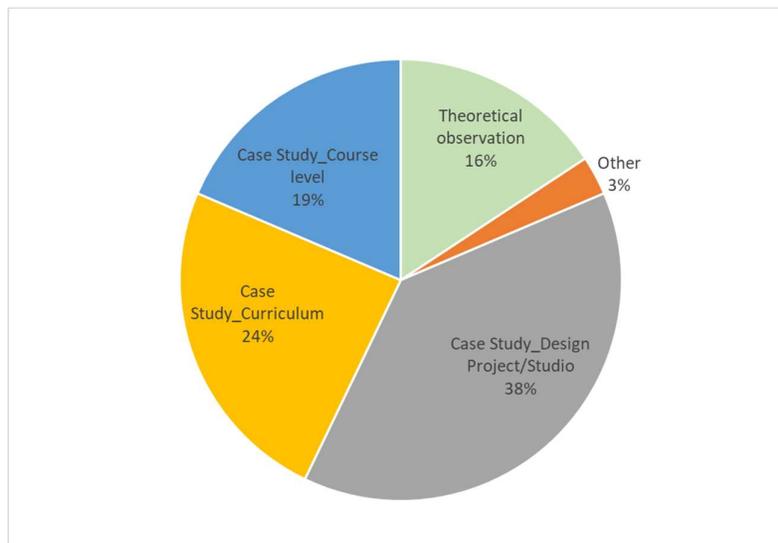


Figure 3: Research methods found in the publications

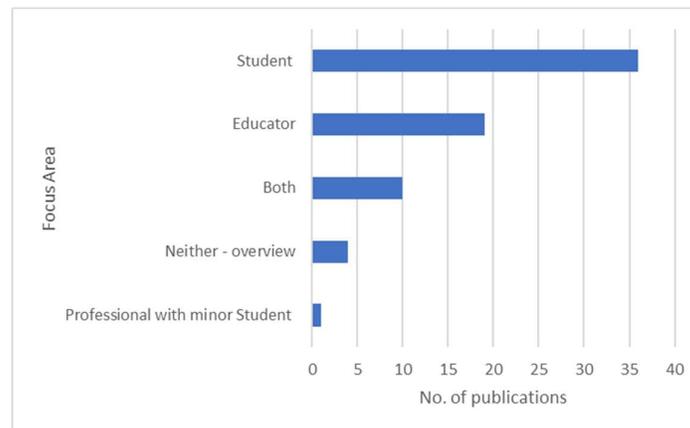


Figure 4: Focus area in the number of publications

The most prevalent research method is case studies, particularly around the ‘design studio’. These were formulated around design studio briefs/ projects, typically isolated from the rest of the courses and the broader curriculum, which may signal a wider lack of curriculum integration beyond project/course level. It is also evident that the main focus of the publications is on *student* skills/knowledge/attributes concerning climate change, rather than on the educators.

The publication analysis is presented below in response to each research question.

RQ1: What pedagogies and teaching methods facilitate the successful integration of sustainable design in architectural education?

Boarin et al.’s paper (2022) provided a good summary of previous studies in this regard, though, it focused on improving student engagement, rather than focusing on educator competencies. In addition to the need for general, holistic integration of sustainability on the course level, a range of other potential **integration strategies**¹¹ were noted (see Figure 5). For example, 1) adding sustainability content to the existing pedagogical framework, 2) selective integration through, e.g., a sustainable design studio and 3) full revision of curricula. Little evidence was offered on the benefits of any one integration strategy over another.

CCD integration needs to occur both across years and within each year¹² and such integration solutions were mainly in problem-solving centred teaching methods such as living labs and live studio projects, where theory is applied in practice.^{e.g., 13} Though these are not generally new ideas in the teaching of architecture, the use of **real-life, collaborative, and interdisciplinary design projects**,^{e.g. 14} together with **digital tools and simulation software**,^{e.g. 15} as well as distance learning, was a novel approach.

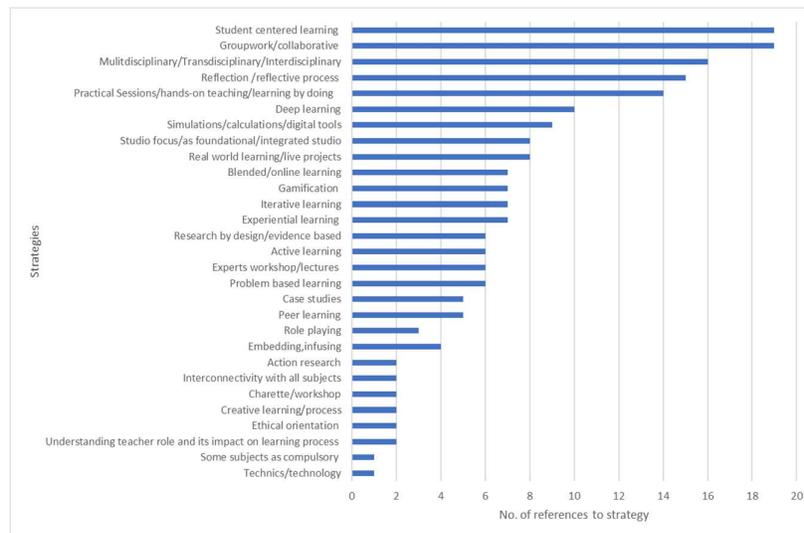


Figure 5: Most advocated teaching strategies and pedagogies for sustainability integration as found in the number of investigated publications

Student-centred learning was seen as the preferable pedagogical approach for successfully integrating sustainability, opposite to transmissive modes of learning. (See Figure 5).^{e.g. 16} In a student-centred approach, the emphasis is on students’ self-awareness, self-evaluation and self-direction, where learning becomes an iterative, reflective conversation rather than a one-way transmission of information from teacher to student.¹⁷ The complexities of sustainability require the ability to discuss and debate, construct and deconstruct ideas, and suggest that focusing on ‘soft skills’ like values, judgement, and critical thinking are as valuable as other ‘hard’ design skills (see also Nisonen, 2022).

Student centeredness often involves using other pedagogical strategies that highlight the need for wide-ranging, multidisciplinary conversations, such as **collaborative learning** through group work, interdisciplinary learning, reflective processes, and deep learning, and learning by doing (supported by digital tools).^{e.g., 18}

While the focus of many of the publications on design studio case studies, with an implication it is an ideal environment for teaching and learning sustainability,^{e.g.19} some made the link explicit, with design studio as the foundational focus of any integrated sustainability curriculum.^{e.g.,20} Additionally, the ability of design studio briefs to use real-world problems, with real-life stakeholders or clients was also noted. Such live projects were seen as a valuable framework for translating theory into practice and providing a tangible platform for understanding projects’ challenges and opportunities.^{e.g.21} The remaining pedagogical approaches ranged from blended learning to technology integration and can be seen in Figure 5.^{e.g. 22}

Pedagogical approaches were also synthesised and categorised into two broad categories, and three sub-categories - under the overarching student-centred learning pedagogy, aligning common approaches or learning outcome aims (see Figure 6). These categories relate to 1) Theory Strategies which feed into the overall curriculum structure, 2) Reflective learning pedagogies, which use collaborative (2a) or Industry integration methods (2b), with Delivery and Implementation methods (2c) to solidify the theory. From this, it is clear that reflective learning pedagogies are critical to successful sustainability integration.

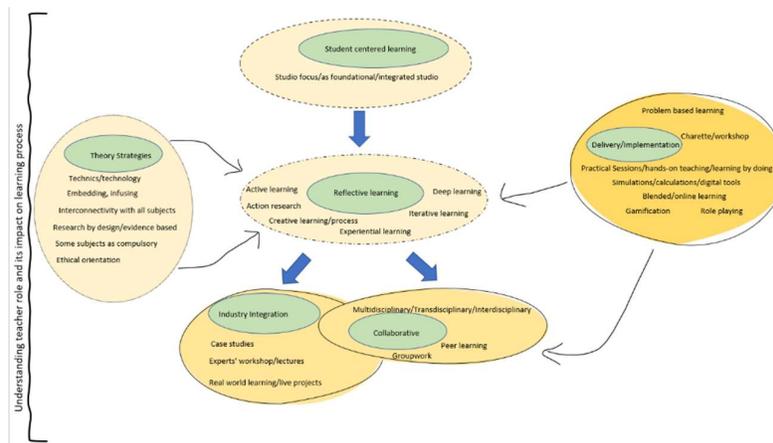


Figure 6: Most advocated teaching approaches and pedagogies for sustainability integration, based on reviewed publications (categorisation by authors)

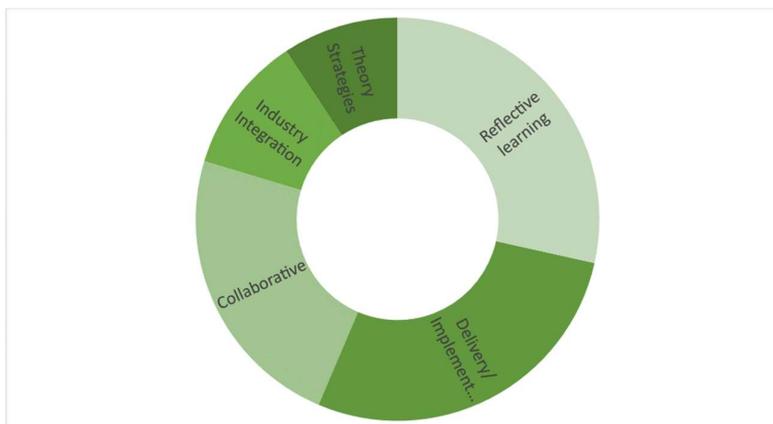


Figure 7: Synthesised Strategies by authors, based on their prevalence in reviewed publications

Very few publications explicitly discussed the required deeper understanding of the teachers' role and its impact on the learning process,²³ highlighting a research gap where teachers skills to deliver CCD are presently assumed.

RQ2: What are skills and competencies needed by educators to integrate [these] sustainable design pedagogies and teaching methods?

There was a general recognition that changing curricula alone will not be sufficient for successful CCD integration. Instead, educator competencies,^{e.g.24} school culture^{e.g.25} and underlying values/goals also need to be addressed.^{e.g.26} Other insights are discussed below; these were typically extracted as side notes and reflections in the publications, as reference to educator skills/competencies was not the focus of most publications reviewed. The same is true of RQ3 and RQ4.

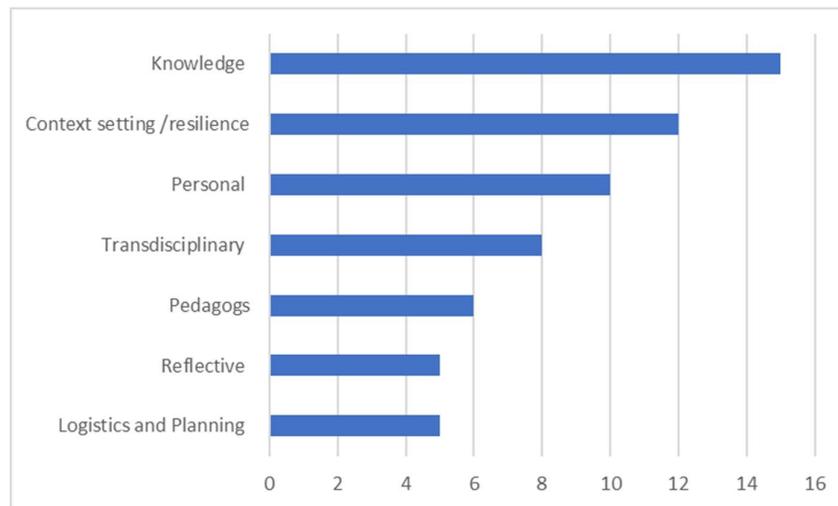


Figure 8: Educator skills and attributes

When synthesised (Figure 8), the required skills/ competencies were seen as, firstly, knowledge around ecological literacy and technical and digital skills in sustainability. Some noted that the application of knowledge depended on individual educators,^{e.g.27} highlighting a potential inequity and inconsistency in approach of teaching. Next, to teach and learn sustainability through student-centred approaches, educators must be flexible and innovative and able to facilitate the learner's personal development and skills instead of just transmitting professional know-how. Educators also need to create the correct setting and context for learning by framing design problems using sustainability as the starting point.²⁸ Teachers' personal 'soft' skills, a shift in values or ethics and a motivation to pursue a sustainability agenda, and were also noted as important,²⁹ as was the use of part-time architects as design studio teachers without the necessary pedagogical understanding.^{e.g.30}

Similar to teaching methods, the need for transdisciplinary teaching teams to facilitate stepping out of silos was noted,^{e.g. 31} as well as the need for educators to have academic knowledge of effective current teaching methods. The need for educators to be reflective, building and learning on past teaching practices was also emphasised in the publications. Lastly, logistical issues related to having sufficient time, resources, and appropriate student numbers to run the particular student-centred strategies were highlighted.

RQ3: What are the barriers and challenges for upskilling educators to attain these skills and competencies?

The most repeated barriers related **to the lack of knowledge and skills of educators**, with insufficient training in sustainability³² and a lack of experts³³ a particular software skill³⁴ or a lack of pedagogical training and awareness of the role of an educator in terms of didactics, teaching and learning.³⁵ This barrier is connected to the previously mentioned external tutors, who either may not have the same understanding of sustainability or do not prioritise it.³⁶ This affects the overall influence on the teaching and learning outcomes³⁷ when course briefs and studio themes are tempered by the studio tutors' interests.³⁸ Other reasons given for the perceived lack of knowledge included the demands of higher education institutions, leaving educators with little time or energy to invest in expanding their knowledge or teaching practice³⁹ and educators not addressing it early enough in their teaching career.⁴⁰ The second barrier related to **issues with defining and scoping sustainability**, with sustainability seen as a contested concept, with fragmented and vague definitions,⁴¹ and the breadth and depth of topics

which are included in the concept, which can be overwhelming.⁴² The resulting reduction or separation of sustainability into technical aspects was noted,⁴³ causing an **“othering” of sustainability** to more traditional architecture concerns, with a “perceived incompatibility between good design and sustainability” A disconnect between ‘green buildings’ that are only discussed in terms of their environmental credentials, rather than their broader architectural merit⁴⁴ and a more traditional design development process⁴⁵ were also noted concerning ‘othering’. A **division between teaching for sustainability and teaching for design** was noted⁴⁶ with the teaching of sustainability still centred on quantitative analysis aspects, which may further exacerbate the complexity and ‘othering’ of sustainability.⁴⁷

Another barrier was the **continued use of traditional transmissive teaching methods**,⁴⁸ where teaching is passive and teacher-centred rather than student-centred.⁴⁹

Difficulties in implementing larger scale curriculum change were another barrier, where sustainability integration was made at the individual studio or educator level rather than integrated into a wider school curriculum.⁵⁰ Some also noted wider cultural issues with a resistance to change⁵¹ and a need to embrace sustainability at a school level⁵² to provide strong leadership⁵³ and a general framework for sustainability⁵⁴ that moves beyond the traditionally siloed disciplines.⁵⁵

Practical, logistical barriers were also noted to do with limited teaching timeframes⁵⁶ lack of financial support,⁵⁷ paucity of facilities,⁵⁸ and the modularisation of the curriculum,⁵⁹ meaning fluidity and spontaneity are challenging, with teaching “tending towards the default”.⁴⁰

Less common barriers referred to general uncertainty within the **architecture profession**⁶¹ and **lack of long term thinking**.⁶²

RQ4: How can these barriers be overcome; as related to teacher competencies, skills, and knowledge?

Firstly, **teaching methods need to be reviewed and diversified** to include innovative and student-centred techniques,⁶³ such as blended learning that support collaboration and reflection.⁶⁴ Moreover, an extensive review of whole schools, courses, and curricula is required to integrate sustainability in the design process and the whole learning culture.⁶⁵ This requires an extensive, flexible framework and staff buy-in.⁶⁶

Secondly, **educators require teacher training early in their careers**⁶⁷ to upskill⁶⁸ but also to create communities of practice to pool knowledge and share best practices.⁶⁹ This was noted as especially important when practitioners make up a high proportion of educators within a school⁷⁰ to enable them to improve their pedagogic skills.⁷¹

DISCUSSION

The publications reviewed for this study demonstrated the student focus of research into methods for integrating sustainability. This might be explained by the publications being authored by sustainability experts with more advanced competencies and knowledge to educate students in this area. However, research and educational development projects are clearly needed to enable upskilling of all educators. Many publications focused on specific aspects of sustainability integration within specific design studios and were solution-focused rather than pedagogically reflective (e.g., focusing on final student outcomes rather than the learning process). While this approach was common in the reviewed publications, there was also a general recognition that having an isolated, content-specific approach will not be sufficient for successful sustainability integration; educator competencies, school culture change, and leadership must also be addressed; as well as wider curriculum changes are also necessary to truly integrate sustainability into the architecture curriculum.

The need to shift from educator-centred teaching methods to student-centred learning methods was made evident with collaborative, reflective, deep learning strategies as key approaches. However, few practical examples of this deeper, more holistic sustainability integration in actual design projects or

processes were given. The lack of literature focused explicitly on teacher skills signals the need for further work in this area to ensure this can be materialised with urgency.

Finally, digital tools can support a more advanced CCD literacy⁷² and foster flexible, independent learning, increased motivation and engagement, contextualisation of knowledge and increased peer-learning opportunities.⁷³ Digital platforms can facilitate student-student learning,⁷⁴ and can be used for blended learning strategies incorporating both online and face to face teaching methods.

Further research and development

The need for a wider framework for sustainability integration is evident in terms of structure and curricula. Any framework for sustainability/CCD integration will have to address practical and logistical differences between courses in different institutions and facilitate a wider curriculum review with organised content around topics, years, and complexity levels.

The successful integration of sustainability calls for upskilling educators beyond subject-based knowledge; as the notable research gap revealed. The facilitation of reflective learning for sustainability is highly dependent on educators' soft skills and personal values, as holistic learning is about developing the whole person, not solely their knowledge base. Educators need to have the means to explore and challenge students' perceptions and to help them discover the complex interdependence of sustainability issues. Without a personal commitment to CCD, a teacher cannot truly teach holistically and critically. Consequently, transitioning from transmissive educator-centred pedagogies to collaborative student-centred ones requires actively tackling educators' teaching methods, values, and behaviour.⁷⁵

Finally, the absence of 'how to' case study examples on new pedagogies, and evidence-based research of successful and (un)successful case studies is necessary.

CONCLUSION

This paper systematically reviewed 71 recent publications on the integration of sustainability in architecture education. Findings included 1) a research gap related to educator skills/competencies; 2) the need for student-centred learning approaches instead of traditional educator-centred architecture design pedagogies; 3) the need for deep, wide structural and curricula change and frameworks to embed sustainability principles and 4) the need for upskilling of educators in sustainability and CCD literacy and didactics, particularly for practitioner educators who are least familiar with pedagogical themes and requirements.

LIMITATIONS

The publications yielded by the systematic review provided a narrower band of publications than a more explorative traditional literature review may provide. However, the latter can be expanded, e.g., by expanding search terms or following references in the publications to ensure a broad, comprehensive overview of the field.

ACKNOWLEDGEMENTS

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NOTES

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