Investigation of architects' needs for upskilling to enable efficient and effective whole house systems-based retrofit in the UK

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Abstract

To meet UK climate targets, all homes need to achieve an EPC band C standard by 2035 and become net zero by 2050 [17]. Only 29% of homes today meet the EPC band C standard, and more than 18 million homes need to be retrofitted. Decarbonisation in existing buildings is one of the main strategies to move toward the zero-carbon agenda in the UK [7]. 'PAS 2035:2019 Retrofitting dwellings for improved energy efficiency – specification and guidance' was developed to provide industry support for whole housing systems-based retrofit. This specifies a range of roles, including retrofit assessors, advisors, designers, coordinators, evaluators and contractors are required to be involved in retrofit projects.

Chartered architects along with the members of CIAT, RICS, CIOB and CIBSE are recognised as competent retrofit designers. However, from experience, there is a lack of experience to implement the whole house system-based retrofit where demand reduction, renewable energy supply and storage must be combined and integrated to achieve targets. Architects need to be upskilled to design appropriate and affordable whole house systems-based retrofit.

This research aims to confirm where architects believe skills are lacking and how best to deliver additional training to address this skills gap through engagement with practicing architects. Appropriate, tailored support will help architects to help deliver UK net zero targets.

This research has been conducted in three steps:
Step 1: Conduct a brief review of the knowledge and skills required for a competent low carbon housing retrofit designer. This involved exploring the literature including PAS 2035:2019 Specification for the energy retrofit of domestic buildings, RIBA Climate Literacy Knowledge Schedule, etc.

Step 2: Design and administer an online questionnaire survey to a sample of 5% of RIBA registered architects in Wales. This will investigate architects' required knowledge and skills in whole house systems-based retrofit design and their preferences on training format and style. The online

questionnaire survey will be disseminated online via online surveys tool. The projected risk is the low response rate to the online survey.

Step 3: Analyse and report online questionnaire survey results: identify the knowledge and skills gap to be fulfilled, and effective training delivery format and style to enable architects to deliver whole house systems-based retrofit and reduce the carbon footprint of all existing housing in the UK.

Based on the survey results, the minimum competencies of retrofit designers confirming essential knowledge and skills required by retrofit designers together will be discussed. In addition, guidance for effective upskilling architects to be competent in whole house systems-based retrofit design that could be used to inform training development can be concluded. It will include learning requirement of each essential component recognised as in each design stage, as well as the knowledge and skills gaps in the whole house systems-based approach to low carbon domestic retrofit.

Keywords: low carbon, retrofit, architects, online questionnaire survey, knowledge dissemination

1. Introduction

The UK Committee on Climate Change [17] determined that Wales should target a 95% reduction of 1990 levels in greenhouse gases emissions by 2050. The Welsh Minister for Environment, Energy and Rural Affairs declared the ambition to bring forward a target for Wales to achieve net zero emissions no later than 2050 [8].

There were an estimated 1,437,600 dwellings in Wales in 2019 [18]. According to the Decarbonisation of Homes in Wales Advisory Group [5], this 1.4 million homes are responsible for 27% of all energy consumed and 15% of all demand-side GHG emissions. Some of the oldest and least thermally efficient housing stock in the UK and Europe can be found in Wales, with 32% of the housing stock built before 1919, and just 10% of homes built after 2000 [5]. At 2022, gas remains the dominant fuel (57%) consumed in domestic buildings, due to the prevalence of gas-powered heating systems [2]. The Welsh House Condition Survey shows Welsh homes have an average SAP rating of almost 61, with 12% of households are living with fuel poverty in 2019 [20].

An affordable and replicable whole house energy systems-based retrofit approach can solve the current challenges, such as high carbon intensive housing stock, growing energy bills and high risk of fuel poverty [10]. There are other factors that might promote the decision for a whole house approach, including the building fabric needing refurbishment, such as re- rendering and re-roofing, which can be a part of the package of energy measures. Energy retrofitting can also improve the health and well-being of occupants, and reduce the burden on the health and social services [11].

The aim of this study is to help upskilling the existing professionals and to identify where architects as retrofit designers believe skills are lacking to undertake a whole energy systems-based retrofit of typical UK homes and how best to deliver the associated training to address this skills gap.

2. Methodology

The development of a low-carbon retrofit course for architects provides an opportunity to engage students, in this case, architects, as active co-creators. According to Healey, et al. [9], being actively engaged in one's own learning is the basic level of engagement. There are two other levels, engagement in quality assurance and enhancement processes, and engagement in strategy development. When engaging in the co-creation of learning and teaching, the role of Consultant identified by Bovill, et al. [4] was planned to apply. At the same time, limitations of partnership with students were recognised, including the risk of ignoring teachers' professional and valuable input and alienating some teachers and students [3]. Therefore, this research centres around a survey of architects' learning needs and preferences.

The research was conducted in three steps:
- Step 1: Low carbon retrofit review;
- Step 2: Survey design and distribution;
- Step 3: Survey results analysis.

2.1 Low carbon retrofit review

To understand the knowledge and skills required for a competent low carbon housing retrofit designer, 2035:2019 Retrofitting dwellings for improved energy efficiency and the Whole House Energy Systems-Based Retrofit developed by the Low Carbon Built Environment (LCBE) team at the Welsh School of Architecture, Cardiff University were reviewed.

PAS2035:2019 Retrofitting dwellings for improved energy efficiency – specification and guidance

Retrofit refers to a range of activities to improve the energy efficiency of buildings through repairs, upgrades, and maintenance to the building itself, as well as changes to power and heat provision and user controls [13].

In relation to domestic retrofit project delivery, the 'PAS2035:2019 Retrofitting dwellings for improved energy efficiency – specification and guidance', sponsored by the Department for Business, Energy and Industrial Strategy (BEIS) was developed by the Retrofit Standard Task Group to provide an overarching framework for domestic retrofit standards; while PAS2030:2019 Specification for the installation of energy efficiency measures in existing dwellings and insulation in residential park homes provides the requirements for the installation, commissioning and handover of retrofit measures. The domestic retrofit process required by PAS2035 and PAS 2030. includes nine stages: Preliminaries, Risk Assessment,

Whole Dwelling Assessment, Retrofit Design, Installation, Testing and Commissioning, Handover, Retrofit Advice, and Monitoring and Evaluation.
PAS2035 specifies a range of roles to deliver a retrofit and a basic level of qualification (Table 1)

Table 1: Retrofit role and required qualification

Role	Qualification	Time to obtain qualification
Retrofit advisors	C&G Energy Awareness or Green Deal Advisor	A minimum of 20 hours to complete the e-Learning course.
Retrofit assessors	Retrofit Assessor Training is designed to upskill qualified DEA/GDAs to undertake retrofit assessments in accordance with the new standard framework.	The retrofit assessor course includes three parts and can be completed in 12 hours learning.
Retrofit designers	Chartered architects (ARB) along with the members of CIAT, RICS, CIOB and CIBSE are qualified as retrofit designers.	No extra training required.
Retrofit coordinators	The Open College Network West Midlands Level 5 Diploma in Retrofit Coordination and Risk Management was developed to train construction site managers, project managers, site managers and assistant site managers as a Retrofit Coordinator.	The guide learning hours for this course is 103 hours. The learners need to obtain all the credits from 12 modules.
Retrofit evaluators	Level 3 Energy in Efficiency and Retrofit of Traditional Buildings	The training is a 2-day course.

Chartered architects (ARB) along with the members of CIAT, RICS, CIOB and CIBSE are qualified as retrofit designers.

The responsibility of a retrofit designer includes designing improvement element of the process, especially those that concern junctions between multiple improvements. To ensure the quality of the design, retrofit designers need to apply their building design and energy efficient knowledge into implementing the low carbon strategies, including analysis of the impact of the individual solutions and present them to the clients. The retrofit designer needs to understand the whole-house systems-based approach, how different trades and suppliers work together and the construction process to ensure all retrofit elements followed through.

LCBE Whole-house systems-based retrofit

The LCBE team at the Welsh School of Architecture, Cardiff University have been working with local authorities and social landlords to deliver systems-based domestic retrofit projects since 2008. The LCBE team use a whole house energy systems-based retrofit approach to reduce energy demand first, then explore the needs and opportunities to integrate renewable energy supply and storage system into the project. The retrofit interventions start with external wall insulation, loft insulation, improved glazing and air tightness. This is followed by consideration of heating and ventilation systems and renewable energy.

- Building fabric improvements, e.g. specifying insulation solutions for the external envelope and cold bridges
- Building services upgrades, e.g. identifying appropriate heating, ventilation and lighting systems
- Renewable energy generation systems, e.g. specifying solar panels
- Energy storage systems, e.g. specifying storage systems

A staged process is employed to ensure that a cost effective and appropriate package of measures was applied to each house type:

- At the start of each retrofit, a **survey** was carried out to understand the existing condition, user behaviour pattern and necessary improvements to the home.

- **Pre-retrofit monitoring** was conducted to collect performance information on air leakage, building fabric, indoor thermal environment and energy usage.

- **Dynamic modelling** was set up and calibrated with pre-retrofit monitored data. The options for retrofit measures were modelled for the home in order to estimate the impact on energy consumption, CO_2 emissions, and operating cost savings.

- **Design** an optimum package of measures for each home with detailed specification, considering budget limits, operational maintenance issues, installation timelines, as well as availability of equipment and materials. All stakeholders were involved in the project decision-making process, including the project research team, project manager, contractors, property owners, and residents.

- **Post-retrofit monitoring** was carried out for at least of a year to explore performance gap and inform future retrofit.

Questions enquired around understanding of architects' required knowledge was based on the review of PAS2035: 2019 Retrofitting dwellings for improved energy efficiency and the LCBE experience of delivering whole-house energy systems based retrofit projects.

2.2 Survey design and dissemination

An online questionnaire survey was designed and administered to investigate architects' required knowledge and skills in low carbon retrofit and preferences on training format and style. The survey contained questions designed to capture information on:

- Respondent profile: the roles and experience of participants, including their current role, size of organisation and experience in low carbon retrofit;
- Training needs: Questions enquired around understanding of required knowledge, in two perspectives: 1) low carbon retrofit stages and 2) low carbon retrofit interventions. Questions also enquired 1) whether a retrofit stage or intervention is important, 2) whether respondents are confident to work with others to deliver it and 3) whether respondents are interested in learning more about retrofit.

- Training preference: enquiries on how the training could be delivered, including the length of a training programme, cost, mode and provider.

The questionnaire was approved by WSA Ethics Review Committee in September 2022. The survey was distributed online via online surveys tool. Dissemination was by email invitation to all (100) RIBA registered architectural practices in Wales and follow-up email reminders and phone calls. The RSAW included the link to the survey in their newsletter sent directly to all registered architects in Wales. The survey was live for four weeks from 20/09/22 to 17/10/22.

2.3 Survey results analysis

The survey results were analysed to identify the knowledge and skills gap and effective training delivery format and style to enable architects to deliver whole house systems-based retrofit and reduce the carbon footprint of all existing housing in Wales. Based on the survey results, the authors plan to apply for funding which aims to engage architects as the Consultant and co-develop a low-carbon whole-house system-based training programme for architects in Wales with consideration of their requirements and preference.

3. Results

A total of 38 responses were received. We could not conclude that the response rate was 38% due to the lack of data supporting only one response from each architectural practice. However, from the following respondent profile, the diverse participant profiles suggested the respondents were from various architectural practices in Wales.

3.1 Respondent profile

The role of participants varied from senior to junior. 72% of the participants were directors and associate directors, 14% of the participants were architects, and 6% were architectural technicians (Figure 1).

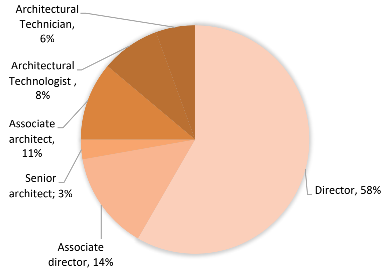

Figure 1. Current role

The respondents worked across all sizes of architectural practices, from micro (1-5 employees) to large companies (50+ employees) (Figure 2).

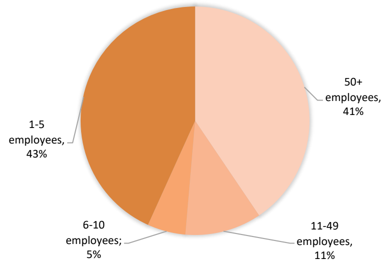

Figure 2. Company size

The participating architects had a broad range of experience in low carbon whole house retrofit, from no experience (47%) to experienced participating in more than five retrofit projects (11%) (Figure 3).

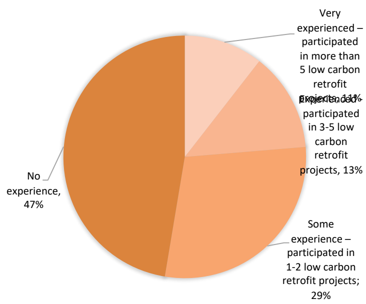

Figure 3. Low carbon whole house retrofit experience

3.2 Training needs

The online questionnaire survey results provide clear evidence on architects' needs and interests in low carbon retrofit training:

- All participating architects suggested the role of architect was important in delivering low carbon whole house retrofit (Figure 4).
- Budget limitations, the lack of knowledge and skills, and client awareness were recognised as the biggest challenges by architects (Figure 5).
- The top three most agreed outcomes of low carbon whole house retrofits included comfortable indoor environment, low cost energy bill and low environmental impact (Figure 6).
- Participating architects' opinion was varied in the modern look and increase house value as the results of low carbon retrofit.

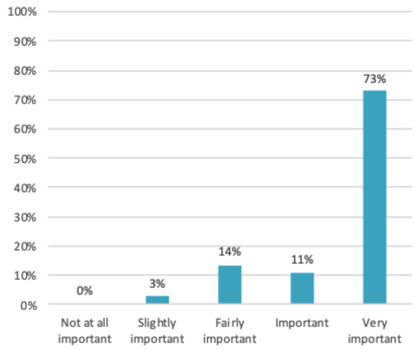

Figure 4. The importance of architects' role in low carbon retrofits

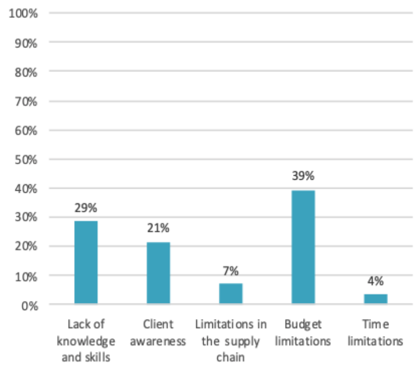

Figure 5. The biggest challenge when working on low carbon retrofits

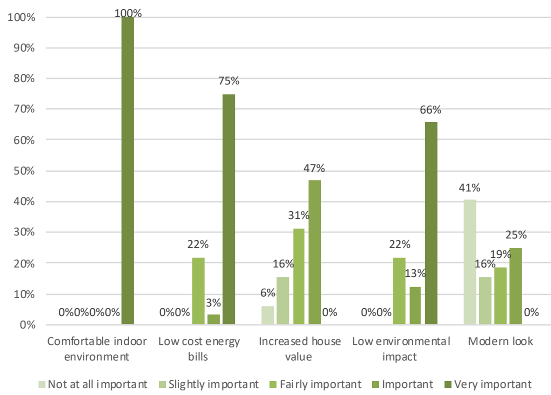

Figure 6. Participants' evaluation on the low carbon whole house retrofits outcomes

In relation to low carbon retrofit stages, participating architects most agreed on the importance of designing and specifying low carbon technologies, surveying to collect information and monitoring post-retrofit performance (Figure 7). Opinion on monitoring pre-retrofit conditions and modelling to compare different strategies varied more, but the respondents were still recognised as important stages by the majority of respondents.

When asked how confident the respondents feel to work with others to deliver each stage in a low carbon retrofit project, the overall confidence level was low (Figure 8). Only 39% of respondents felt they were confident in the design stage, while 37%, 46%, 25% and 31% of them felt confident in survey, pre-retrofit monitoring, modelling and post-retrofit monitoring respectively.

All participating architects demonstrated their strong desire to learn at every stage (Figure 9).

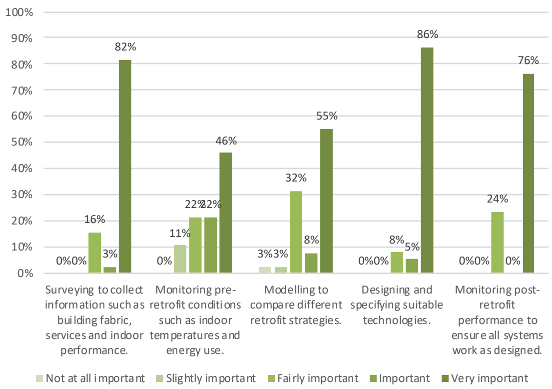

Figure 7. Participants' evaluation on the importance of each stage in the low carbon whole house retrofit process

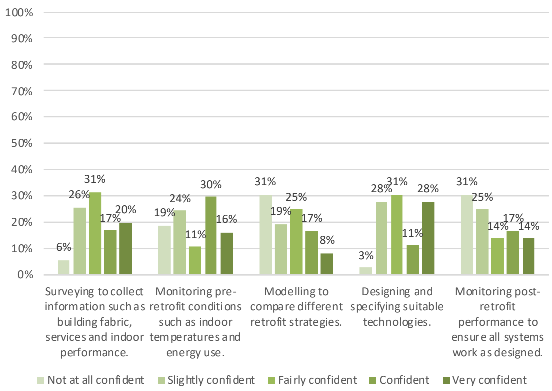

Figure 8. Participants' evaluation on their confidence at working with others to deliver each stage in the low carbon whole house retrofit process

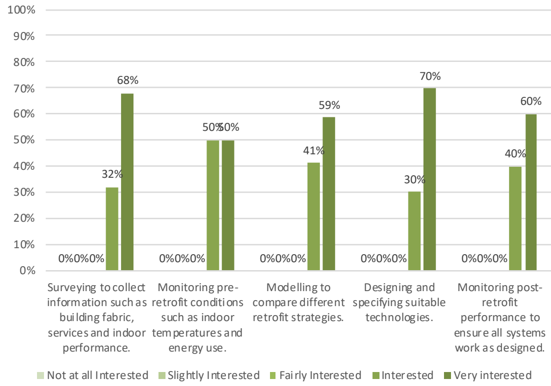

Figure 9. Participants' evaluation on their interests in learning each stage in the low carbon whole house retrofit process

In relation to low carbon retrofit interventions, participating architects mostly agreed on the importance of building fabric improvement and building services upgrade in low carbon whole house retrofit (Figure 10). Opinion on renewable energy supply and storage system varied more but were still recognised as important interventions by the majority of respondents.

When asked how confident they feel to work with others to deliver each intervention in a low carbon retrofit project, the overall confidence level was low (Figure 11). 43% of participating architects felt they were confident in building fabric improvement, while 14%, 15%, and 9% of them felt confidence in building service upgrade, renewable energy generation system and storage system respectively.

Understandably, all participating architects demonstrated their strong desire in learning every intervention (Figure 12). The pattern of responses to the three questions on low carbon retrofit interventions was similar to the one on low carbon retrofit stages.

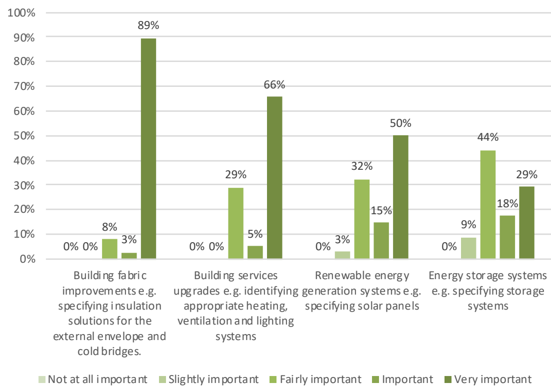

Figure 10. Participants' evaluation on the importance of each intervention in the low carbon whole house retrofit process

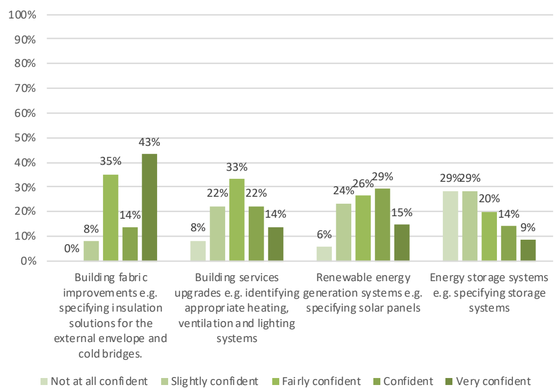

Figure 11. Participants' evaluation on their confidence at working with others to deliver each intervention in the low carbon whole house retrofit process

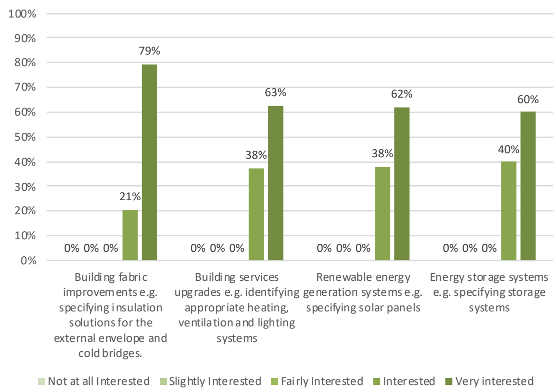

Figure 12. Participants' evaluation on their interests in learning each intervention in the low carbon whole house retrofit process

3.3 Training preference

Participants provided responses in their training preference, in relation to the length of a low carbon retrofit training programme, the cost, the mode and the provider (Figure 13):

- Approximately, half of participating architects suggested they were prepared to pay between £50 to £100 for a two-hour training course, while 30% of respondents were willing to pay between £100 to £250.
- The preferred length of the low carbon retrofit training was half a day (37%), more than one day (26%) and one day (24%).
- Respondents expressed preference in all three delivery modes, with a bit more in favour of blended format (47%). 29% and 24% of participants chose face to face and online courses respectively.
- There were widespread views on the provider to deliver the low carbon retrofit training: a professional body (42%), a certified training body (33%) and a university (14%).

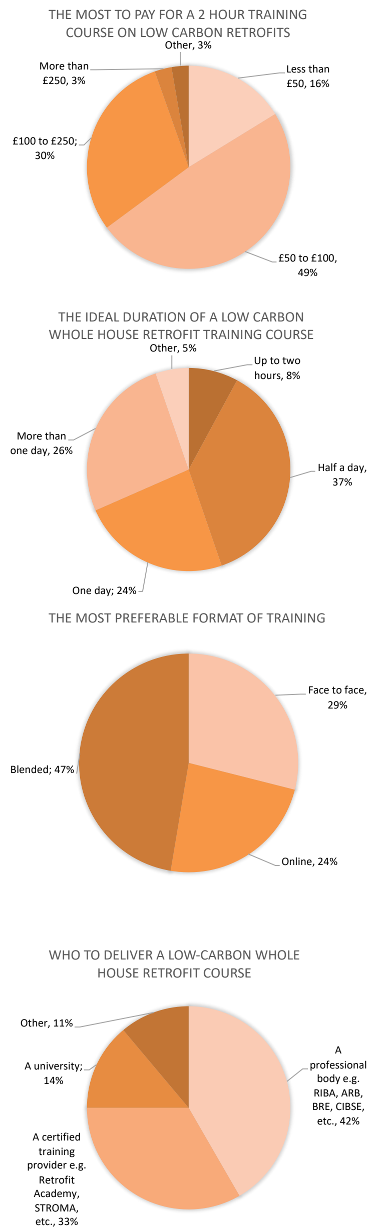

Figure 13. Training preference

4. Discussion and Conclusion

Through the review of PAS2035: 2019 Retrofitting dwellings for improved energy efficiency and the LCBE team's whole house energy systems based retrofit, retrofit designers were recognised as having the ability:

- to work and communicate with other professionals, including retrofit assessors, coordinators, evaluators, monitoring specialists, modellers and contractors, to deliver each stage of low carbon retrofit from survey, pre-retrofit monitoring, modelling, design, construction to post-retrofit monitoring.

- to apply a holistic approach and lead specification and design integration of each intervention of low carbon retrofit, including: 1) Building fabric improvements, 2) Building services upgrades, 3) Renewable energy generation systems, and 4) Energy storage systems.

The respondents' self-evaluation of experience in low carbon retrofit project suggested that architects lacks experience in working on low carbon whole house retrofit projects.

Consistent patterns were identified across the answers to the questions on low carbon retrofit stages and interventions: participants recognised the need for an architect to engage at each retrofit stage or intervention, and a general lack of confidence in working with others to deliver each stage and intervention in the low carbon whole house retrofit process and desire to learn. Considering these participating architects are qualified retrofit designers according to PAS 2035, the need to upskill is recognised.

There was no correlation recognised with their role in practice (from architectural technicians to directors) and the size of the architectural practice.

The Royal Institute of British Architects recognised the education of future chartered architects, and the professional development of those who have already achieved chartered status, needs a great emphasis on the climate emergency that our world faces [15]. Architecture schools are going through the process of redesigning programmes to meet the RIBA Climate Literacy Knowledge Schedule. Retrofit, adaptation and reuse is one of the 40 subject areas. At the same time, the new RIBA Education and Professional Development Framework identified mandatory competency for each career role and level. Climate literacy was set as a mandatory competency for an established professional (qualified architects with less than 5-year experience).

Professional body started to place a higher level of importance on climate emergency in 2019. An absence of low carbon retrofit in the existing architecture education curriculum to that date means practising architects lack the necessary expertise in whole house systems-based retrofit. This will lead to further delay in relevant architecture education as architectural educators/ design tutors are not trained to share this knowledge and skill in design studio. The opportunity for architectural students to learn about the low carbon retrofit is therefore limited even when introduced at the programme redesign.

It is crucial to develop continuing professional develop programme to enable all practising architects to deliver low carbon retrofit projects and decarbonise existing housing stock, especially as technologies and solutions are in the developmental stage and are very different to traditional practices. Respondents provided views on how to deliver training, suggesting the low carbon retrofit training can be potentially used as part of RIBA CPD obligations. Hands on experience and real-world practicalities were repeatedly mentioned and desired.

Research teams in universities, such as the LCBE team at WSA, Cardiff University, that participated in a range of retrofit and delivered more than 30 retrofitted homes would meet the requirement to deliver the training. In addition, universities' connection and network were also valued by survey participants when choosing training providers.

With regards to learning preferences, the participating architects indicated a wide acceptance range of cost and programme length. Blended learning was favoured as the delivery mode for the low-carbon retrofit programme, combining face-to-face and online components and integrate a range of learning activities [1]. Based on a systematic review on the effectiveness of blended learning, all reviewed studies indicated that when students participated in blended learning, their academic achievement was higher than that of students who participated in a face-to-face only or online only learning mode [14]. Also, Blended learning offers flexible time and location access and self-direction. Among the models of blended learning, such as flex learning, self-directed blended learning and supplemental blended learning, the flipped classroom where students learn online materials before attending the face-to-face sessions was considered to be a solution which aligns with the Bloom's Taxonomy [12].

In conclusion, practising architects were aware of a lack of knowledge and experience in whole-house energy systems-based retrofitting and expressed an interest in learning relevant skills. Teams with extensive low carbon retrofit experience were in a position to bridge the knowledge gap and share experience and lessons learnt in whole house retrofit with qualified architects and Part two students, with their developed expertise in survey, monitoring, modelling, designing, procurement and working with all stakeholders. The knowledge dissemination could kick start a positive loop in closing the gap, with experienced retrofit designers as design tutors bringing the knowledge, skill, and retrofit experience to design studios to empower emerging architects and work effectively towards the net zero carbon target in 2050.

References

[1]Ali Alammary, Judy Sheard, and Angela Carbone, 'Blended Learning in Higher Education: Three Different Design Approaches', Australasian Journal of Educational Technology, 30 (2014).

[2]Sam Alvis, James Fotherby, Helena Bennett, Zoe Avison, and Joseph Evans, 'Closing the Uk's Green Skills Gap', (London: Green Alliance, 2022).

[3]C. Bovill, 'A Framework to Explore Roles within Student-Staff Partnerships in Higher Education: Which Students Are Partners, When, and in What Ways?', International Journal for Students as Partners, 1 (2017).

[4]Catherine Bovill, Alison Cook-Sather, Peter Felten, Luke Millard, and Niamh Moore-Cherry, 'Addressing Potential Challenges in Co-Creating Learning and Teaching: Overcoming Resistance, Navigating Institutional Norms and Ensuring Inclusivity in Student–Staff Partnerships', Higher Education, 71 (2016), 195-208.

[5]Decarbonisation of Homes in Wales Advisory Group, 'Better Homes, Better Wales, Better World: Decarbonising Existing Homes in Wales', (2019), p. 65.

[6]Department for Business Energy and Industrial Strategy, '2020 Uk Greenhouse Gas Emissions, Final Figures', (London: 2022).

[7]E. Green, S. Lannon, J. Patterson, F. Varriale, and H. Iorwerth, 'Decarbonising the Welsh Housing Stock: From Practice to Policy. ', Buildings and Cities, 1 (2020), 277-92.

[8]Lesley Griffiths, 'Written Statement: Response to Committee on Climate Change's Net Zero Report'2019) <https://www.gov.wales/written-statement-response-committee-climate-changes-net-zero-report> [Accessed 03/04 2023].

[9]Mick Healey, Kristine Mason O'Connor, and Patricia Broadfoot, 'Reflections on Engaging Students in the Process and Product of Strategy Development for Learning, Teaching, and Assessment: An Institutional Case Study', International Journal for Academic Development, 15 (2010), 19-32.

[10]Miltiadis Ionas, Jack Morewood, Joanne Patterson, Emmanouil Perisoglou, Esther Tallent, Xiaojun Li, Ester Coma Bassas, and Shan Shan Hou, 'Whole House Energy System Retrofit of Six Off-Gas Bungalows in South Wales', (CABE Research Forum: 2022).

[11]Phillip Jones, Xiaojun Li, Emmanouil Perisoglou, and Joanne Louise Patterson, 'Five Energy Retrofit Houses in South Wales', Energy and Buildings, 154 (2017), 335-42.

[12]Colin James Lumsden, Lucie Byrne-Davis, and Karen Scott, 'Blended Learning', in A Handbook for Teaching and Learning in Higher Education: Enhancing Academic Practice. , ed. by H. Fry, S. Ketteridge and S. Marshall (London: Routledge, 2009).

[13]N Murtagh, AM Owen, and K Simpson, 'Beyond Drivers and Barriers: A Theoretical Framework Addressing the Engagement of Uk Construction Practitioners in Retrofit for Energy-Efficiency', in SEEDS International Conference 2020 Sustainable Ecological Engineering Design for Society (Online: 2020).

[14]Oleksandra Poquet, Srecko Joksimovic, Vitomir Kovanovic, Shane Dawson, Dragan Gasevic, and George Siemens, 'The History and State of Blended Learning', (2015), pp. 55-92.

[15]RIBA, 'The Way Ahead', (London: RIBA, 2020), p. 11.

[16]The Retrofit Standard Task Group, 'Pas 2035:2019 Retrofitting Dwellings for Improved Energy Efficiency – Specification and Guidance', (London: BSI, 2019), p. 50.

[17]The UK Committee on Climate Change, 'Uk Housing: Fit for the Future?', (London: 2019).

[18]Welsh Government, 'Dwelling Stock Estimates for Wales, as at 31 March 2020', in Stastical Bulletin (2020), p. 24.

[19]Welsh Government, 'Energy Use in Wales', (2022), p. 36.

[20]Welsh Government, 'Welsh Housing Conditions Survey 2017-18: Energy Efficiency of Dwellings', in Statistical Bolletin (2019), p. 42.