Designing for dementia; insights from experiential learning in undergraduate education

#647 - Designing for Dementia; Insights from Experiential Learning in Undergraduate Education

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Abstract

Dementia-friendly design is an increasingly urgent concern as populations age and care needs become more complex. This study explored how architectural engineering education can support inclusive and sustainable responses to dementia through experiential learning. It examines the work of undergraduate students enrolled in a core design module (ArcD) within a BEng/MEng Architectural Engineering program at a UK university. Students were tasked with designing dementia-friendly bungalows that address cognitive, sensory, and physical needs, while integrating sustainability and assistive technologies. A qualitative thematic analysis of 35 anonymous student submissions collected over three academic years (2022–2025) identified six key design strategies: user-centred planning, sensory and cognitive support, inclusive outdoor spaces, community-oriented layouts, sustainability, and technological integration. The findings confirm alignment with the established dementia-care design literature, such as prioritizing accessibility, reducing agitation, and promoting social engagement. However, the study also revealed how students extended the design brief by incorporating emerging technologies (e.g., smart sensors and adaptive lighting) and culturally specific features that foster psychological safety and identity. These socially and environmentally responsive innovations reflect how future practitioners can interpret and evolve inclusive designs in response to shifting global concerns. This analysis further highlights the pedagogical value of project-based and design-thinking approaches in fostering critical, empathetic, and technically competent graduates. Despite variations in cultural awareness and real-world feasibility, student work demonstrates how inclusive design principles can be embedded meaningfully within technically rigorous curricula. This study contributes to emerging conversations about inclusive design pedagogy by showing how dementia care principles can be taught using studio-based methods. It also offers recommendations for enhancing cultural sensitivity, industry collaboration, and scalability of future curricula. Architectural engineering education, when designed with intention, can play a transformative role in preparing students to meet the social and environmental challenges in contemporary care environments.

INTRODUCTION

Dementia remains a pressing global health and social-care challenge. In the UK, nearly one million people are currently living with dementia, and this figure is projected to reach two million by 2051 (Dening, 2022, Alzheiner's Society, 2024). As the population ages, there is a growing demand for environments that promote independence, safety, and well-being among individuals with dementia. Dementia-friendly design has emerged as a critical response, focusing on how the built environment can reduce anxiety, support cognition, and improve the quality of life (Marquardt et al., 2014). Increasingly, these designs are expected to incorporate sustainable construction strategies and smart technologies to address environmental and social concerns.

Although dementia-friendly design is well documented in professional and healthcare contexts, relatively little is known about how such principles are introduced and interpreted in undergraduate architectural education. This gap is particularly notable in interdisciplinary fields such as Architectural Engineering, where students must balance technical performance with user-centred design. Research on engineering education demonstrates that pedagogical frameworks such as experiential learning and design thinking can significantly influence students' values, priorities, and problem-solving approaches (Deng and Liu, 2023, Olewnik et al., 2023). However, few studies have examined how these frameworks are applied to train students to respond to complex care needs such as dementia.

This study addresses this gap by examining how students engage with dementia-care principles in the Architectural Design 2 (ArcD) module, a core component of the BEng/MEng Architectural Engineering program at a UK university. The module adopts a pedagogical model that combines iterative studio-based learning with reflective practice and a real-world design. Students are tasked with designing dementia-friendly bungalows that incorporate evidence-based strategies for cognitive, sensory, and physical needs, while integrating sustainability and assistive technologies.

The remainder of this paper is organized as follows. The next section reviews the literature on dementia-friendly design and educational frameworks relevant to Architectural Engineering. This is followed by a description of the ArcD module and the qualitative case study methodology used to analyse student work. The results section presents six key themes that emerged from the analysis of student submissions, illustrating how the dementia-care principles were interpreted and applied. These findings are discussed in relation to the existing literature and pedagogical theory, with a focus on how inclusive design thinking can be fostered through architectural education. The paper concludes by reflecting on the implications of curriculum development, interdisciplinary teaching, and innovation in dementia care design.

LITERATURE REVIEW

Designing environments that support the cognitive, emotional, and physical well-being of individuals with dementia is a well-established research area. A range of architectural strategies such as improved spatial orientation, sensory adaptation, clear wayfinding, and social inclusion have been shown to significantly enhance the quality of life of people with dementia (Fleming, 2020, Marquardt, 2011, Marquardt et al., 2014). These strategies are increasingly aligned with sustainable and technological innovations that aim to improve the long-term environmental and operational performance (Ismail et al., 2023).

Central to these strategies is a user-centred design that supports cognitive, physical, and emotional well-being. Research has consistently shown that features such as non-slip surfaces, clear signage, and accessible layouts enhance safety and reduce agitation (Caspi, 2014, Wiener and Pazzaglia, 2021). Simple and predictable floorplan typologies are particularly effective in the early stages of cognitive decline, helping to reduce disorientation and support independent navigation (Marquardt, 2011, Marquardt and Bueter, 2023). Sensory adaptations, including circadian lighting schemes and sound-absorbing materials, further promote comfort and minimize overstimulation (Vincent and Hartt, 2024). Simultaneously, communal spaces, such as shared kitchens, gardens, and activity rooms play a crucial role in fostering social connections, reducing isolation, and reinforcing identity. Van Steenwinkel et al. (2019) highlighted how domestic-scale settings encourage informal socialization and a sense of belonging, whereas tools such as Plan-EAT offer evidence-based frameworks for their integration (Quirke et al., 2023). Together, these spatial, sensory, and social strategies reflect a holistic understanding of users' needs for dementia care.

Moreover, sustainability and technological innovation are becoming increasingly central to dementia-friendly design. Research highlights the potential of integrating eco-friendly materials, passive solar strategies, and renewable energy technologies, such as photovoltaic panels and rainwater harvesting systems, into care housing to reduce environmental impact and operational costs (Pearson, 2019). Complementing these sustainability measures, smart home technologies, including motion sensors, automated lighting, programmable thermostats, and air quality monitors can enhance daily life by responding to cognitive and physical needs (van Hoof et al., 2013). Projects such as the INDEPENDENT initiative demonstrate the value of combining architectural and digital interventions to promote well-being and support meaningful activities (Torrington, 2009). These sustainable digital approaches reflect a forward-looking model of dementia care that addresses individual and environmental needs.

However, despite the breadth of innovations in both spatial and technological domains, the implementation of dementia-friendly environments continues to face systemic and pedagogical challenges. Golgolnia et al. (2023) noted the lack of systematic tools to evaluate design effectiveness, while Catt and Giridharan (2018) highlighted inconsistencies in

translating well-being principles into practice. These issues are compounded by a pedagogical implementation gap. Although the literature provides a robust foundation for dementia care design, little attention has been paid to how future architects and engineers can be trained to apply these principles.

Architectural education remains a critical, but underexplored, avenue for cultivating inclusive design literacy. While some studies have called for greater integration of social and psychological concerns into architectural curricula, there is limited empirical evidence on how students engage in dementia-specific design strategies. Scott et al. (2018) demonstrated that inclusive design pedagogy, particularly when delivered through participatory projects with older adults, can enhance students' empathy, cultural awareness, and ability to respond to real-world needs. This highlights the importance of embedding inclusive design principles early in architectural education rather than treating them as supplementary content.

Recent educational research suggests that embedding design challenges that prioritize user needs and social impact leads to deeper student engagement and skill development. Design-thinking pedagogy, which encourages iterative problem solving, systems thinking, and empathy, has been successfully applied in engineering education to foster cross-cutting competencies essential for contemporary practice (Deng and Liu, 2023). Olewnik et al. (2023) highlighted how project-based learning can cultivate adaptable, socially responsive engineers by situating students within complex, real-world challenges. These pedagogical strategies closely align with the aims of the Architectural Engineering Programme explored in this study, in which students are required to integrate inclusive design, sustainability, and technical performance into their design responses for dementia care. However, the specific application of these pedagogical principles in undergraduate architectural engineering education, especially in relation to vulnerable user groups such as individuals with dementia, remains under-researched.

This study addresses this gap by exploring how dementia-friendly design is introduced and interpreted in the undergraduate architectural design module. It contributes to emerging conversations around inclusive design pedagogy by demonstrating how educational frameworks can bridge the gap between theoretical knowledge and practical applications. In doing so, it highlights the potential of architectural education to act as a catalyst for cultivating empathy, fostering innovation, and embedding real-world impact in future dementia care environments.

RESEARCH METHOD

Educational framework and module context

This study adopted a qualitative case study methodology to examine how undergraduate students interpret and apply dementia-friendly design principles in a structured

architectural education setting. The focus is on the ArcD module, which is part of the BEng/MEng Architectural Engineering program at a university in the UK.

The module is grounded in Kolb's experiential learning theory (Kolb et al., 2014) and structured around a project-based learning model. Students work on a real-world design brief: to design a dementia-friendly bungalow that balances inclusivity, technological integration, and environmental sustainability. Learning is scaffolded through weekly lectures and studio sessions that blend technical development with design empathy, supported by formative feedback, peer interaction, and reflective practice.

As discussed in the literature review, design thinking pedagogies— emphasizing empathy, systems thinking, and problem solving in complex, real-world contexts—are increasingly recognized for their value in engineering education (Deng and Liu, 2023, Olewnik et al., 2023). These pedagogical frameworks directly shape the structure and assessment of the ArcD module, which aims to cultivate inclusive, socially responsive, and technically competent graduates. Figure 1 illustrates the ArcD project-based learning process, which begins with the real-world brief and progresses through studio-based exploration, formative critique, reflective practice, design development, and presentation. The cycle concludes with reflective learning, reinforcing concepts for future modules and identifying areas for individual growth.

Importantly, the module's pedagogical design centres on embedding socially conscious design challenges, such as dementia care, into early architectural engineering education. However, it has also been acknowledged that students' outputs may reflect broader societal narratives, including evolving attitudes toward aging, care, and inclusion, beyond the direct influence of instructional design.

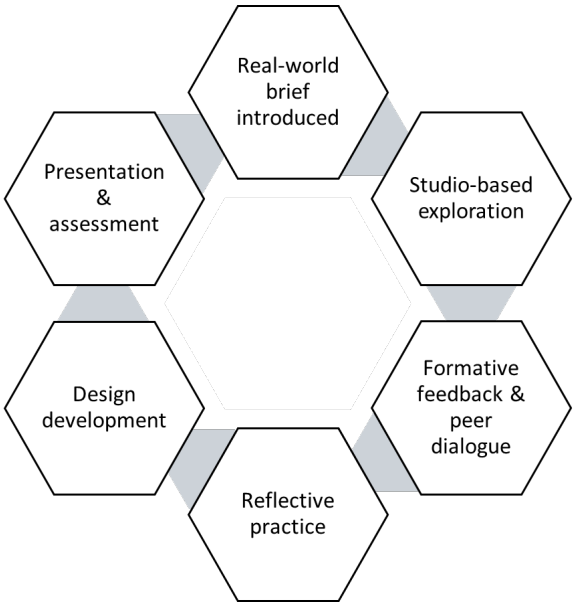

Figure1: Project-based learning process in ArcD module.

Data collection and scope

The dataset comprises 35 individual student submissions from the 2022/23, 2023/24, and 2024/25 academic years. These include:

1. Design reports (literature reviews, precedent analyses, site studies)
2. Final pinboard presentations (drawings, spatial diagrams, user narratives)
3. Studio feedback records (notes from tutor–student interactions)

During studio sessions students are encouraged to develop and share their design work with the instructor and other students following Dutton's description of the design studio as: "compared to typical classroom scenarios, studios are active sites where students are engaged intellectually and socially, shifting between analytic, synthetic, and evaluative models of thinking in different sets of activities (drawing, conversing, model-making)" (Dutton, 1987 p.16). Moreover, students are encouraged to keep a design diary, to demonstrate the development of their design, such diary "collects ideas and drawings chronologically. Doing so allows concepts to be referenced over time and provides a record of how a project develops and evolves. At certain points it may be necessary to pause, reflect and reconsider the design direction. A design diary allows the process of the project to be traced back as a lineage of design development." (Farrelly, 2007).

In 2022/23 and 2023/24, the module was delivered as a third-year course, whereas in 2024/25, it was repositioned to the second year as part of a wider curriculum review. The module convener was kept consistent throughout the experiment. Of the 35 submissions, nine students (26%) achieved an A grade, 11 students (31%) received grade B, 14 students (40%) were awarded grade C, and only one student (3%) failed. Table 1 presents the details of the submissions. All analysed submissions, except for one, met the standardized learning outcomes for the module, ensuring a baseline level of conceptual and technical competence. The high proportion of A and B grades, particularly among third-year cohorts, reflects strong evidence of independent research, creative engagement, and thoughtful application of dementia-care design principles.

Academic year	Number of students	Assessment marks
2022-23	9 students	Two students =A Six students = B One student = E (fail)
2023-24	6 students	Five students = A One student = B
2024-25	20 students	Two students = A Four students = B Fourteen students = C

Table 1: Details of the students' work.

Analytical approach

Qualitative thematic analysis was conducted following the principles of applied thematic analysis, which emphasises systematic, transparent, and iterative coding procedures to generate trustworthy interpretations from textual data (Guest et al., 2011). The aim was to identify recurring strategies and design concepts embedded in student submission. The coding focused on both explicit dementia-related design decisions (e.g., layout planning, sensory adaptation, wayfinding, and environmental control) and broader themes such as sustainability and technological integration.

The analysis was conducted by the author who also convened the module. A reflexive approach was adopted throughout the process to mitigate potential bias and ensure analytical rigor. This involved multiple close readings of anonymized student submissions, allowing themes to be refined through iterative review cycles. The emerging codes were continuously compared against the module's intended learning outcomes and aligned with established dementia-design literature to ensure validity. Although inter-rater reliability was not pursued due to the sole authorship of the study, a transparent audit trial was maintained throughout the analysis to support the credibility of the findings.

RESEARCH RESULTS

This section presents a thematic analysis of student projects focusing on designing dementia-friendly environments. The findings were structured around six key themes that illustrated how students interpreted and addressed the needs of individuals with dementia in their design strategies.

1 User-centred design for dementia

A significant focus across student projects was on creating designs that priorities the independence and safety of individuals with dementia. Examples include open-plan layouts to reduce navigation challenges, visible and accessible bathrooms to enhance convenience, and step-free access to mitigate the physical barriers. Additionally, handrails, non-slip flooring, and clear signage were integrated to minimise accidents and promote confidence in movement. Features such as memory aids, clear signage, and open shelving further mitigate the cognitive decline. Many designs have also emphasized futureproofing by incorporating flexible layouts and structural provisions for mobility aids and car accommodations. In one project, a student proposed a "memory corridor" with personalized photo displays to support residents' recollection of important life events. Another design integrated open-plan living spaces with visible pathways to key areas such as bathrooms and kitchens.

2 Cognitive and sensory support

Many designs have addressed sensory challenges faced by individuals with dementia. High-contrast colour schemes and lighting strategies are frequently used to enhance the visual clarity and reduce confusion. Advanced lighting solutions for the regulation of circadian

rhythms, such as tailored natural and artificial lighting, have also been highlighted. The projects also emphasized acoustic comfort, integrating materials to reduce reverberation and background noise and creating calm and sensory-friendly spaces. For instance, one student suggested using sound-absorbing materials in communal areas to prevent overstimulation and ensure a calm environment. Another proposed adjustable LED lighting system maintains circadian rhythms and improves the sleep patterns.

3 Integration of outdoor spaces

Outdoor spaces are key elements in fostering well-being and social interactions and contribute to a holistic approach by providing secure and accessible areas that encourage physical activity, sensory engagement, and social connections. Students proposed multifunctional gardens designed not only for recreation but also for therapeutic activities, such as gardening and birdwatching. Covered seating areas are often included to ensure year-round usability, and shared outdoor spaces are planned to encourage interactions among residents while maintaining privacy. One project featured a central communal garden surrounded by bungalows, designed to promote socialization and interaction among residents while providing private seating areas for solitude. Another design included sensory gardens with distinct zones for various activities such as gardening, walking, and relaxation.

4 Community and social inclusion

Designs seek to combat loneliness by fostering social connections. Communal areas such as shared gardens and hobby rooms were included to encourage interaction among residents. Projects often feature flexible spaces that can accommodate social gatherings and individual activities, thereby reflecting the diverse needs of patients with dementia. Some designs have also proposed integrating culturally specific aesthetics and layouts to reflect the backgrounds of potential residents, foster a sense of belonging, and reduce anxiety. One student designed a communal kitchen and activity room to host group cooking sessions and workshops to foster a sense of community and inclusion.

5 Sustainability and energy efficiency

Sustainability is a recurring theme, with students integrating eco-friendly materials, energy-efficient systems, and passive housing principles to address contemporary environmental challenges in their designs. Features such as solar panels, green roofs, and high-performance insulation systems have been proposed to minimize environmental impact and reduce operational costs. Prefabricated wooden structures have been highlighted for their low embodied carbon, quick assembly, and alignment with environmental goals. One project used rainwater-harvesting systems and solar panels to create a self-sustaining energy model for a housing complex. Another study employed locally sourced materials and green roofs to enhance the thermal performance while improving biodiversity.

6 Technological integration

Integration of assistive technologies is another prominent strategy. Students proposed smart home systems, such as motion sensors, reminder alarms, and automated lighting, to support independent living. These technologies were designed to enhance safety and convenience using features such as programmable thermostats and adaptive lighting to assist residents with cognitive and physical challenges. Additionally, systems to optimize indoor environmental quality, such as air quality monitors and adaptive climate controls, have displayed innovative approaches to dementia care. One submission featured a smart kitchen with automated stoves and a barcoded microwave to prevent user errors and improve safety. Another project proposed environmental monitoring systems to maintain optimal temperature and air quality within homes.

DISCUSSION

Alignment with literature

The findings of this study align closely with established research on dementia-friendly designs. Student submissions consistently incorporated recognized features, such as open-plan layouts, accessible bathrooms, memory aids, and non-slip flooring, echoing Caspi's (2014) and Marquardt and Bueter's (2023) emphasis on spatial legibility and safety. Sensory design elements, such as adjustable lighting for circadian regulation and sound-absorbing materials, further reflect Boger et al.'s (2013) findings on the importance of reducing agitation through environmental comfort.

Notably, student projects have extended the current literature in two ways. First, while communal spaces are frequently cited in research as supporting social inclusion and emotional well-being (Van Steenwinkel et al., 2019), students reinterpreted this principle by embedding culturally specific aesthetics and spatial layouts into their designs. Several proposals featured domestic-scale shared kitchens, gardens, and multi-use rooms designed not only to encourage interaction but also to reflect the cultural identities and lived experiences of future residents. These strategies aim to foster familiarity, belonging, and psychological safety, which remain underemphasized in the literature on dementia design.

Second, sustainability and technological integration, although already acknowledged in the literature (van Hoof et al., 2013), were pushed further into student work. The projects included emerging technologies, such as smart environmental sensors, adaptive lighting systems, and air quality monitors, alongside renewable energy systems, such as solar panels and rainwater harvesting. These proposals reflect a forward-looking interpretation of dementia care that responds to both digital innovation and environmental sustainability.

Together, these findings suggest that architectural education, when grounded in real-world design briefs, can cultivate not only an understanding of established best practices but also a creative capacity to anticipate and address emerging challenges in dementia care environments.

Pedagogical impacts

Beyond the design content, this study provides insights into how inclusive and socially responsive competencies can be fostered in architectural engineering education. The ArcD module, informed by Kolb's experiential learning theory and design-thinking pedagogy, creates an iterative, reflective, and user-focused learning environment.

Its project-based structure encourages students to navigate ambiguity, empathize with users, and integrate original evidence-based strategies. This aligns with the findings of Deng and Liu (2023) and Olewnik et al. (2023), who noted that design thinking enhances ethical reasoning, systems thinking, and interdisciplinary problem-solving. In this context, students were not only able to apply theoretical principles, but also to adapt and extend them, particularly in the areas of cultural considerations, sustainability, and technological integration.

Importantly, even students in the 2024/25 cohort who engaged in the module earlier in their studies produced well-resolved and imaginative proposals. This suggests that complex care themes, such as dementia, can be introduced successfully at earlier stages of design education, provided that they are appropriately scaffolded. It also reinforces the value of design-based pedagogies in cultivating cognitive empathy and socially attuned problem solving.

Reflections on challenges and pedagogical context

Although the overall quality and depth of student work were encouraging, several challenges have emerged. One recurring issue was inconsistency in how students addressed cultural inclusivity. Although many designs reflect an awareness of diverse user needs, others only demonstrate surface-level engagement with the psychological and social dimensions of dementia care. This highlights the need for additional scaffolding, such as structured workshops or exposure to culturally diverse case studies, to support consistent application of inclusive design principles.

Another challenge is the gap between the conceptual design and practical implementation. Although many submissions were creative and forward thinking, they often lacked direct engagement with feasibility constraints or user input. Strengthening collaboration with dementia care professionals and offering opportunities for prototyping or feedback within the studio process could help students ground their proposals in real-world conditions.

Finally, the findings reflect the convergence of pedagogical structures, student agency, and broader societal influence. Students from varied cultural and educational backgrounds brought diverse perspectives to their work, often responding to emergent global concerns such as sustainability, aging-in-place, and inclusivity, even when these were not explicitly emphasized in teaching. Although the module was led by a single academic, the assessments were moderated by another academic to reduce the bias. These conditions position the

findings not as universally generalizable but as a compelling case of how pedagogical environments can align with and amplify wider generational and cultural values in the formation of socially responsive design.

CONCLUSION

The ArcD module showed that experiential project-based learning can effectively support students in developing the empathy, creativity, and technical proficiency required for dementia-friendly design. Through iterative studio work, evidence-based research, and reflective practice, students produced proposals that addressed cognitive, sensory, and physical needs, while integrating sustainability and technology.

Student work aligns with core principles from the literature, but also extends them, particularly in the areas of cultural inclusivity, environmental design, and digital innovation. These findings highlight the potential of architectural engineering education to prepare students to design inclusive, adaptable, and socially attuned environments.

This module offers a valuable model for embedding socially relevant design challenges in technical curricula. By continuing to emphasize real-world applications, interdisciplinary collaboration, and inclusive pedagogy, the approach can be refined and adapted to other educational contexts globally.

Future research directions

Future research could explore how similar modules operate across institutions, to better understand the transferability of this approach. Interviews, reflective essays, and longitudinal tracking can provide richer insights into how students interpret and apply inclusive design principles over time. Involving end users and care professionals in co-design or review processes would also enhance the evaluation of student proposals and strengthen the links between education and practice.

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