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DESIGNING A SUSTAINABLE BUILDING: A REFLECTIVE TEACHING CASE

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INTRODUCTION

The development of design ideas is at the core of education in creative based fields where the employment of skills and experiences is by nature a reflective practice inquiry. In the architectural studio, classes are organised around *set* projects of design usually drawn from *real world* practice (Schön, 1983; Schön, 1987). The teacher's position here is to find opportunities to consider the role of creative processes and technical knowledge in developing *workable* situations (Heath, 1984, p.74). On a similar note, Seferin (2010) stated any architectural project is bound by its context, so the kind of information, approach, and structure needed are directly related to the given context of the design problem.

This research is a case study with the empirical material consisting of investigations based on the designing process of a demonstration sustainable building project by a group of students. It also provides a perspective on how a sustainable building can potentially influence the values held by the students involved with it, and how this experience can inform and enrich their environmental values.

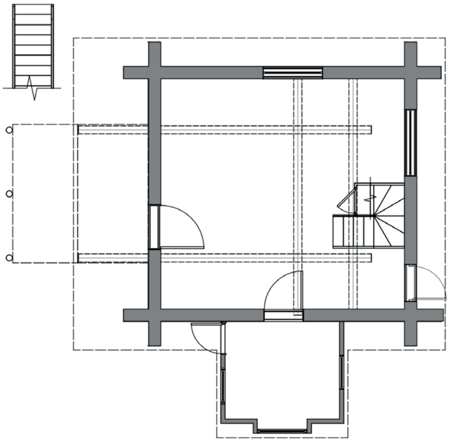

Figure 1. Views of the Log Cabin, (a) from the northwest, (b) ground floor plan, the log cabin before the improvements.

The building in question is a Log Cabin (LC) at Otatara Hills in Hawke's Bay, New Zealand, on a site that is part of the Eastern Institute of Technology (EIT) (Figure 1(a)). The Otatara Hills site is an example of a place that has strong historic, cultural, and spiritual associations with local Māori (Pishief, 1997). The development of the project included refurbishing a modest LC that was empty and decaying to become a demonstration facility for showcasing sustainable building design and construction technologies, and to be used as an educational tool and focus for the behaviour and values that support sustainability. Formerly, the LC was used as a staff office space and later as a teaching studio space and an artist-in-residence living space, but it was in a state of disrepair before this project started. The reuse of old buildings rather than demolishing and building new has been recognised as an aspect of sustainable building (Storey, 2017).

The LC is square in plan with an internal footprint measuring 6x6 metres and includes a small lean-to accessed through a door in the centre of the southern wall and a mezzanine level accessed from a stair against the north wall (Figure 1(b)). Although a building of solid log walls might not seem an ideal starting point for a demonstration sustainable building, without retrofitting, this unoccupied building would have continued to deteriorate and might well have been demolished. The problem was to find ways to minimise the environmental impact of the converted building that would be both appropriate and affordable.

AIMS

The aim of the study is to educate the students about what sustainable living practices are through engaging in a reflective practice inquiry of designing a demonstration project for sustainable building. This also includes the process of creating a brief for the demonstration project, *what* can be learnt in terms of environmental knowledge, and in what way this example may contribute to inspiring the behaviour of those who will come to be in contact with it. Acknowledging this, the case study is conducted with an outcome and a process in mind.

The brief for the LC was complicated because the design was to be developed by a group of students as part of teaching. At the time, the LC had no particular function beyond serving as a demonstration building for the public, and the costs of retrofitting had to be sourced through sponsorship. As it was to act as a demonstration building, the techniques and methods incorporated within it had to be appropriate to the building types and materials found locally. Beyond this, making sense of sustainable design in architecture tends to be confusing considering the quantity of information on the subjects of green and sustainable buildings (Guy & Farmer, 2001).

SETTING UP THE PROJECT

Sustainable building practice can be seen as a set of environmental, technical, social, and ethical issues with the general objective of reducing human impact on the earth. Accordingly, the project strategy was first established to create a framework for retrofitting and refurbishing the LC at Otatara.

Project design team

As mentioned before, the concept for the project's refurbishment would be generated and developed by students at EIT. Eventually these students would become part of this research investigation. Thus, rather than supplying a brief for the project retrofit, this was to be discussed and generated by a group of Second Year students in the EIT Visual Arts and Design (VAD) programme as part of a Design Studio course. The educational aim was to adopt a reflective teaching method that would enable meaningful learning (Smith, Hedley, & Molloy, 2009; Schön, 1983). To facilitate working with a group of students who want to influence behaviour through design (Tromp, Hekkert, & Verbeek, 2011), the need for responsible environmental attitudes to manifest the context of sustainability and ecology through design was discussed, coupled with applying *design thinking* in dealing with environmental, social and ethical issues in addition to the technical and architectural context (Dorst, 2011).

Nineteen design students were invited to take part in formulating the initial concepts, and six opted to become involved, with the remainder choosing to work on other projects for various reasons. Consideration was given to writing the project brief criteria so that they would fit with the teaching curriculum.

Aims and guideline to students

In response to the context of the brief, the integrated and interactive model adopted in the design studio aimed to address the demands of the project while enabling specific and meaningful generic learning. The teaching model was outlined by defining the learning strategy and describing the structure and content of study (Smith et al., 2009; Schön, 1983).

At the beginning, the students were presented with a set of aims and guidelines for the building refurbishment. These were established by comparing standards and recommendations from a number of national and international sources in order to find out what characterizes a sustainable building.

A design strategy was then established for the LC guided by the following parameters: the philosophy of integrating renewable low energy design with low environmental impact of materials; aiming to achieve a net-zero energy building (Net ZEB); using recycled building materials and components; treating wastewater; and reducing mains water use and the burden on existing infrastructure through collecting rainwater. The challenge to the students was to integrate these approaches and consider the environmental impact of materials. The results would be checked against passive solar energy targets (Passive House Institute New Zealand [PHINZ], 2014), and the renewable energy systems production checked against modelled consumption once a design was established.

In relation to specification of sustainable materials, the student designers looked at sources including the Building Research Association of New Zealand (BRANZ) and the Building Research Establishment (BRE) in the UK, for guidance. They were also to refer to the UK Code for Sustainable Homes (CSH) as a guide to overall building performance (CLG, 2006) and CO_2 emissions reduction (Sleeuw, 2011).

The project approach incorporating the teaching stages of the module was explained, see Figure 2. The students were also advised of being involved as actors in the research project.

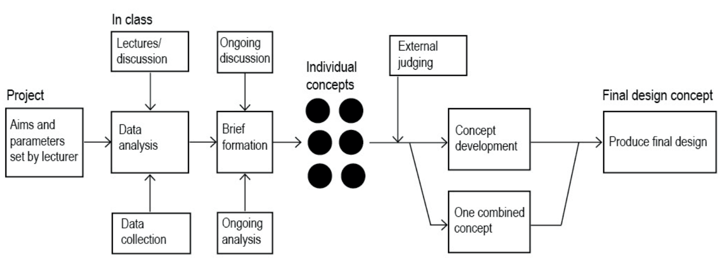

Figure 2. Flow diagram of the LC concept design process.

Using the parameters identified, the students were given a project timeline (Figure 3).

Weeks	Period	Activity
29, 30	16 July – 27 July	Stage 1: Research
31, 32, 33	30 July – 17 August	Stage 2: Design Concept – preliminary
34, 35	20 August – 31 August	Stage 2: Design Concept – presentation
36, 37, 38, 41	3 Sep – 21 Sep	Stage 3: Development design-preliminary
42, 43, 44	8 Oct – 2 Nov	Stage 3: Development design – final presentation

Figure 3. The project brief timeline.

Project design criteria

Using the parameters identified, the LC project brief was discussed with the students and the following aspects were explained as part of the data collection and analysis stage (Stage 1): indoor thermal comfort, passive solar design, a Net ZEB, impact of materials, recycling of materials, wastewater and sewage treatment, and water conservation. These aspects were first examined separately, although recognising there will be interactions.

THE PROJECT BRIEF

The students worked as a group to formulate a project brief and to establish a framework for retrofitting and improving the LC to become a demonstration sustainable building (Bahho, Vale, & Milfont, 2015).

Research and data collection

Based on the project design criteria above, the purpose of the design brief was to enable the student designers to create a concept for refurbishing the LC and to document it. The intention was to think of, and deal with, the fundamental issues of how the building could be constructed, and to think about how those who live in such buildings should operate them. These views were enhanced during the studio sessions through showing a series of sustainable building projects, such as Roaf's Oxford House, 1995 (Roaf, Fuentes, & Thomas, 2001), Vale and Vale's New Autonomous House, 1993 (Vale & Vale, 2002), Thomas Herzog's Housing Development Project in Munich, Germany, 1982 (Ingeborg, Herzog-Loibl, & Meseure, 2002), and talking about how the architects' views might have influenced the project.

Updating guideline topics

In the process of formulating the project brief, and based on CSH, the students were asked to discuss and explore sustainable practices applicable and suitable for the concept design. Each student was asked to gather and analyse information on one specified research topic chosen from indoor thermal comfort, passive design, Net ZEBs, impact of materials, recycling, wastewater and sewage treatment, and water conservation. Two students looked at the first three topics because of their interrelated data and complexity leaving the other four topics to one student each to investigate.

As a result of the data analysis and conversations, the students decided to update the classification of topics given in the project brief guidelines. Indoor thermal comfort and passive solar design topics were combined into an *energy conservation* category and a *renewable energy systems* category was introduced to complement the Net ZEB energy objective. They introduced a *healthy indoor air* category to include natural lighting and ventilation as well as material toxicity, and a *sustainable landscape* category. The focused environmental themes and their categories are shown in Figure 4 and compared with the CSH criteria.

THE PROJECT CONCEPT DESIGN

In response to the context of the project brief, an integrated and interactive model was adopted in the design studio aimed at addressing the demands of the project while enabling student exploration. The teaching model was outlined by defining the learning strategy and describing the structure and content of study.

The learning strategy

Through the design studio, the students were exposed to a number of experiences that focused on two areas: the first was *how to design*, introduced by engaging with the design process within the generic framework of analysis, synthesis, and evaluation; and the second was to reveal knowledge about aspects or situations through the act of designing. So the emphasis shifted from facilitating an understanding of design and designing to focusing on the ability of design to reveal new understandings of ecological and sustainability issues. The latter included giving consideration to social issues (Bahho, 2013).

As all students in the group would have experiences of the built environment as users, their understandings and everyday experiences were used as a starting point, through studio and group discussions, to inform what was to be designed, its effects on the relationships between people and the environment, and the associated design processes.

Category	LC Project Brief Requirements	CSH Standards
Energy conservation	To utilise solar design for passive heating and cooling, as well as making use of natural lighting and ventilation.	A 'zero carbon home'* is rated at 6-Star level (heating, lighting, hot water, and all other energy uses in the home) (CLG, 2006, p.10).
Renewable energy systems	To include solar photovoltaic systems, solar hot water heating systems, and eco types of electric lighting and Energy Star appliances.	
Impact of materials	To consider embodied energy of materials used for framing and finishing.	The total building points under CSH material calculator achieve the score of 15 points. Scores are added for; roof structure and finishes, external walls, floors, internal walls, and windows and doors (CLG, 2006, p.16).
Materials recycling and reusing	To use recycled materials and building components in the retrofitting, such as window joinery, and bathroom fixtures and fittings.	
Wastewater and sewage treatment	To recycle grey water and to treat black water.	On-site treatment of solid waste from the building (CLG, 2006, p.11).
Water conservation	To save rainwater by storing the roof runoff	Internal potable water consumption is less than 80 litres per person per day (CLG, 2006, pp.10, 15).
Healthy indoor air	To consider achieving minimum average daylight and ventilation factors. To include the use of low or no-VOC paints, durable and formaldehyde-free materials.	To meet the minimum standards of daylight (CLG, 2006, p.21)
Sustainable landscape	To include the use of drought tolerant plants, and high efficiency irrigation system. To consider including a glasshouse to grow veggies all year round.	Not included in CSH, added specifically to the project.

** The terms zero carbon and zero energy are interchangeable in their application to define buildings with very high-energy efficiency ratings (EPBD, 2011, p.7).*

Figure 4. LC project brief category requirements compared to CSH criteria.

Learning structure and content

The studio format can be described within the three key areas of class organisation, the establishment of key design concepts as core content, and supporting resources and documentation.

The class organisation demanded a less formal and a more collaborative approach considering the small student group, in a responsive and flexible environment. The content material was delivered in a design studio setting rather than formal lectures. Two weekly sessions broken down to three hours of critique and six hours of tutorials formed the teaching and learning focus of the project design. The last three hours of tutorials were dedicated to forums and workshops to discuss, resolve, and consolidate a number of issues related to the project design so that students would have a holistic understanding of the issues being explored.

The core content was driven by themes intended to introduce relevant design knowledge and skills as well as to develop a designer way of thinking. The content was delivered within three interactive components. The first was the *context* component, which introduced the importance of ecological considerations and addressing environmental issues through design in relation to the built environment. These ideas were discussed during consolidation sessions in the afternoon tutorials. The student group sat with the author, who was the main teacher, to discuss and resolve various aspects of the building design in a workshop setting. This was intended to widen the ideas, for discussion of relevant issues and concerns, and particularly for performing project-related calculations. The *process* component consisted of exploring techniques and issues of design thinking by introducing relevant theory focusing on the process, not the completed work. It was delivered as part of the critique and during the morning part of the tutorials, focusing on the building project solutions and what skills were needed to design the building retrofit. Finally the *communication* component introduced a variety of techniques of visual communication in the context of design language. These skill sessions were also delivered during the afternoon part of the tutorials.

The core resources and documentation supporting the project design activities were recorded in the studio workbook in three areas. The first, *design guidelines and criteria,* would enable the students to commence the project design work. The learning occurred through focused engagement with the resource material that had to be selected, reviewed, and interrogated critically through the design activities. Secondly, *documentation of processes* including all exploratory and reflective work in response to the activities related to the project. This enabled the students to externalise their processing and, subsequently, to allow both students and staff to use it as a basis for reflection and evaluation. Lastly, the *visual diary* was a vehicle to record and critique issues related to the project graphically, through which students could develop skills in drawing and visual representation.

PROJECT DESIGN CONCEPT

During the design concept stage (Stage 2), the students visited the site and analysed the building and its surroundings (Figure 5). Later, each student investigated and initiated a personal concept for the refurbishment where visualisations of the student's inspirations, beliefs, and creative solutions could be manifested.

Figure 5. Students' site and building visit at the research stage (Bahho, 2018, p.172).

The students went to various sources for information and inspiration. In addition, they were presented with lectures covering fundamental concepts of sustainable design including relevant examples. They were referred to particular library and online resources (Kwok & Grondzik, 2007; Lehman & Crocker, 2012; Mithraratne, Vale, & Vale, 2007; Reardon, 2008; Wilhide, 2002, Yeang, 2008). A trip to the First Light House in Waimarama, Hawke's Bay, was organised. The house was designed and built as part of the Victoria University of Wellington's School of Architecture syllabus for the 2011 Solar Decathlon competition (Victoria University of Wellington [VUW], 2011). Figures 6 and 7 show one student's concept stage submission.

Student designers pre-engagement focus group interview

At this point of the design stage, the first student focus group was conducted to investigate knowledge and concerns about sustainability issues, before their engagement in the project. This and analysis of the results is described in detail below in the section titled 'STUDENT DESIGNER FOCUS GROUPS.'

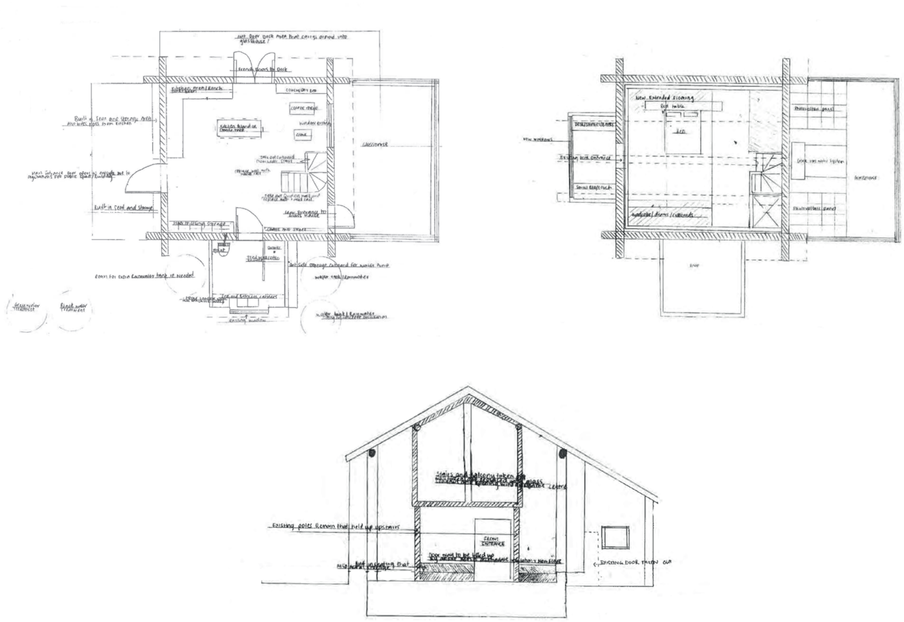

Figure 6. An example of one student concept design submission (Bahho, 2018, p.173).

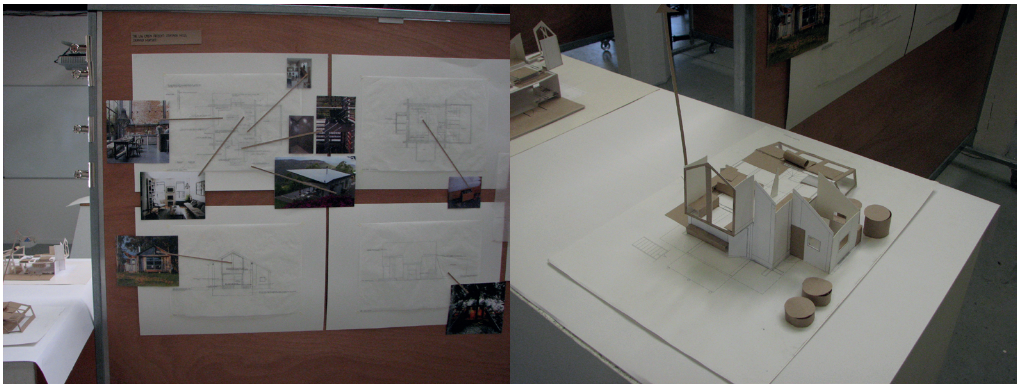

Figure 7. The presentation of the student concept shown in Figure 6 (Bahho, 2018, p.173).

Sustainable building practices, considerations and solutions

The intentions of the project were to find solutions and techniques for sustainable building practices that would be *generic* and easy-to-apply, so as to motivate anticipated visitors to adopt environmentally responsible improvements in their homes. The related discussions took place in Stage 2 and continued in Stage 3, the development stage of the project. The topics developed by the students and noted above are described in more detail here:

Energy conservation and renewable energy systems

For passive solar techniques, studio discussions focused on improving the thermal insulation and airtightness of the building, and evaluating this with the BRANZ Annual Loss Factor (ALF) tool for calculating the energy performance of a New Zealand house (Bassett & Stoecklein, 1980). As a result, students decided on a layer of roof insulation and wall insulation within an additional internal timber frame to the external log wall. The uninsulated concrete slab presented a problem. Ideally its mass should be part of the passive solar design (BRANZ, 2013) but not without insulation. Rather than digging up and relaying the slab, the students proposed a thin layer of under-floor insulation with a tile finish so as to use as much of the existing building as possible.

Furthermore, the students suggested adding a *greenhouse* to the existing structure, facing north so the direct solar gain would heat the air, which would be vented by convection into the interior living space (Energy Efficiency and Conservation Authority [EECA] 1994; Gong, Akashi, & Sumiyoshi, 2012; Kachadorian, 1997).

Building	Heating Energy demand (kWh/m^2year)	Results
Log Cabin Project	16.52	ALF calculates the LC requires 1,203 kWh/year of heating energy for the total area of 73 m^2
Passive House	15	A certified Passive House has to meet a specific space conditioning demand of not more than 15 kWh/m^2year (Grove-Smith & Schneider, 2011).
Typical NZ house	28.94	Average energy use in a typical NZ house of 132 m^2 is 3,820 kWh/year (Isaacs et al., 2010).

Figure 8. Comparison of expected Required Heat Energy (RHE) in LC with other values.

The Required Heat Energy (RHE) for the LC project design was compared to the PHINZ standards and also to average New Zealand home energy use from the New Zealand Home and Energy End-use Project (HEEP) (Isaacs et al., 2010) (Figure 8). It was significant to get the RHE of the LC design close to the Passive House energy demand specifications especially considering the LC is a retrofit project. The proposed design easily complied with Clause H1 of the NZBC, with a Building Performance Index (BPI) of 0.85 kWh/(m^2. °C. month) compared to the required 1.55 kWh/(m^2. °C. month).

A solar photovoltaic panel system to generate the energy required was endorsed and its capacity, size, and location investigated using BRANZ resources (Figures 10 and 11). Hot water was intended to come from a redundant evacuated tube collector solar hot water system relocated from the Caretaker's House on EIT campus.

To maximize energy savings, students suggested using power efficient Energy Star® rated appliances and installing energy-saving Halcyon LED lights throughout, although maximum use would be made of daylight. Being an existing building, window size and orientation were already determined. Students discussed improving the thermal performance of the windows together with lighting and ventilation in the studio.

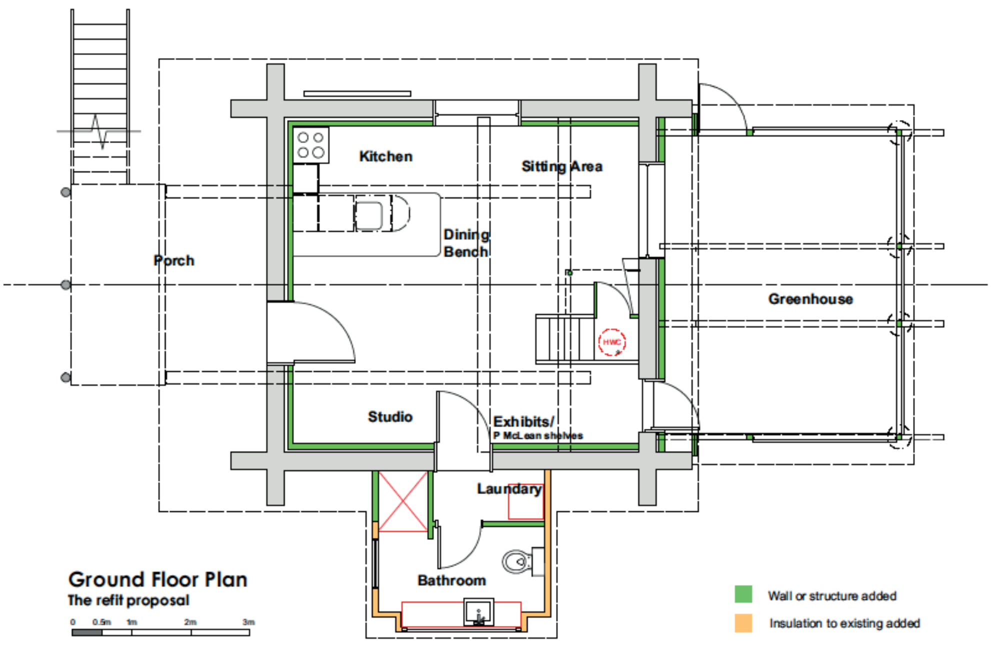

Figure 9. The combined student concept design, ground floor plan (Bahho, 2018, p.177).

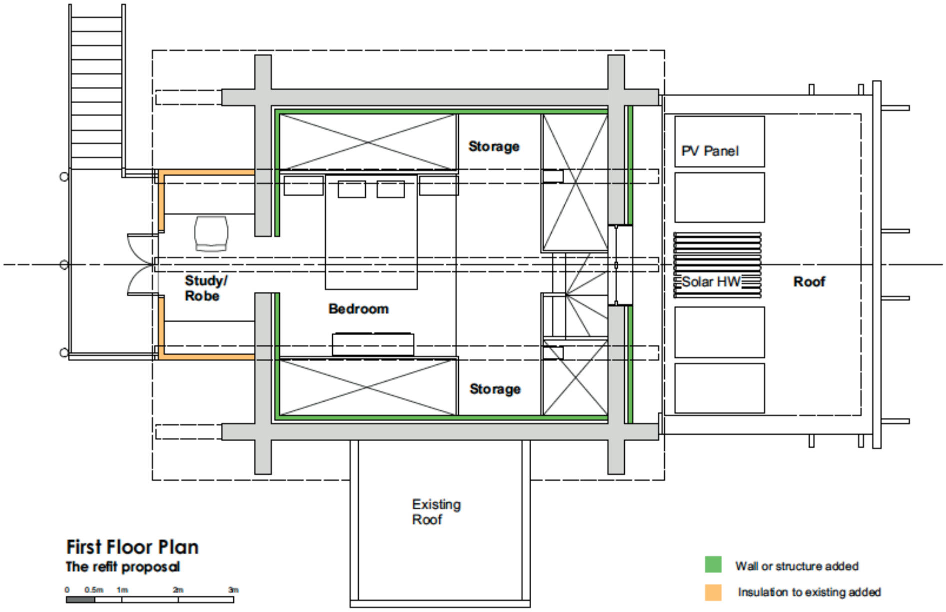

Figure 10. The combined student concept design, first floor plan (Bahho, 2018, p.177).

Sustainable building materials and techniques

Timber, as a renewable structural building material with low embodied energy (Sustainable Design Award, 2004), was chosen for the framing of the greenhouse and the new internal lining to the external log walls, see Figures 9, 10, and 11. The consolidation discussions fixed on this as being recycled timber as much as possible. Fibreglass Pink Batts® were preferred for insulation as they are locally made and use up to 80 percent recycled glass (Pink Batts®, 2011).

For windows, recycled timber would be used for repairs and to make them suitable for new double-glazing units to replace the single glass. Some thin window sections such as those in the bathroom and French doors, meant some could be secondary glazed without completely replacing them with new double glazed units (EECA, 2017). Recycled single glazed window frames would be used for the greenhouse walls. The existing kitchen joinery would be repaired and retrofitted, and recycled bathroom fixtures would be installed, including shower, basin, and toilet.

The design students were careful to specify low-embodied energy materials as well as recycled materials and building components wherever practical.

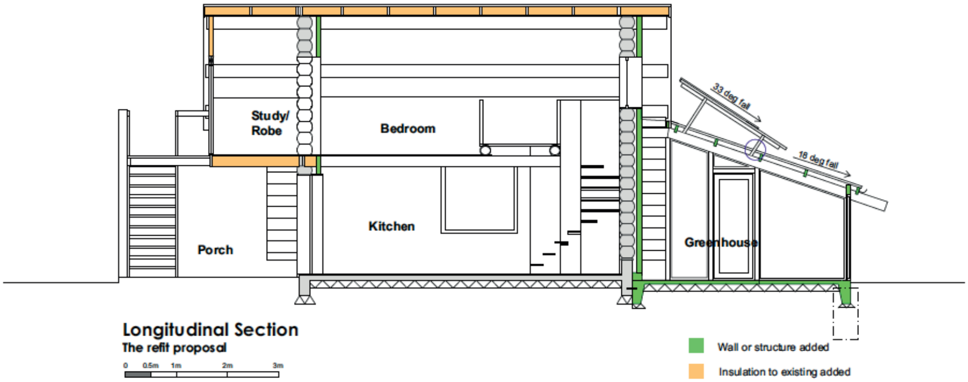

Figure 11. The combined student concept design, longitudinal section (Bahho, 2018, p.178).

Sewage and wastewater treatment

Low-flow toilet fixtures and aerators were discussed as a means of saving water, although these are initially expensive. The group discussed trying to find sponsors who would be keen to provide the products and showcase them to the public, or sourcing a recycled toilet, shower, and washbasin. Eventually, the second option was adopted. A similar discussion occurred with regards to the choice of a washing machine which was between the preferred low star-rated appliance for its low water usage and energy saving, and a recycled option should the new one be unaffordable.

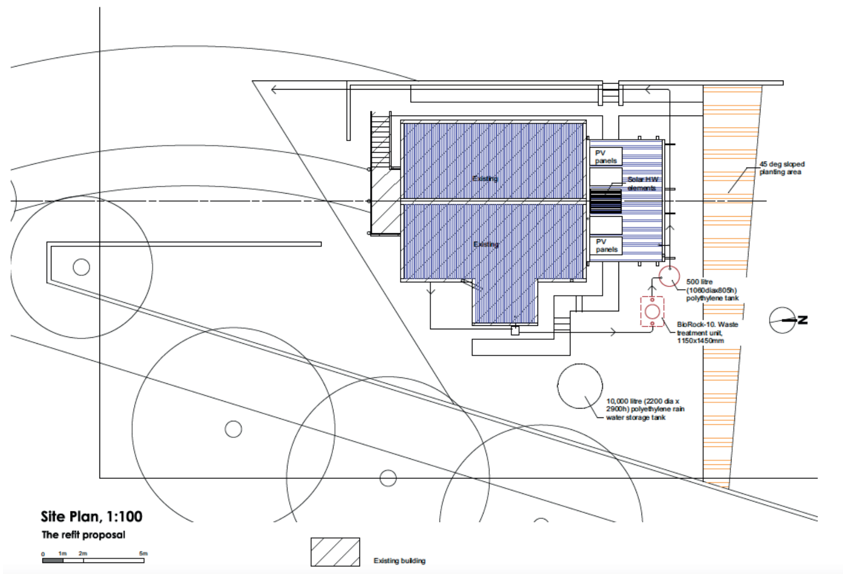

Figure 12. The combined student concept design, site plan (Bahho, 2018).

The students suggested using a sewage and wastewater treatment plant. The recycled effluent would be used in the greenhouse and any excess would be discharged to a nearby drip-line effluent field (Figure 12). Studio discussions found all types of sewage treatment plant had positive and negative points. Bio sewage systems that use worms and other organisms would be organic but were not suitable for low occupation or intermittent use. On the other hand, a septic wastewater treatment plant could handle low flow rates but would need a small pump to reuse the treated effluent. However, this could be added to an existing septic tank, hence making it suitable for demonstrating what people could do at home, see Figure 12.

Capillary mats were proposed as an effective irrigation method to rationalise the use of treated wastewater in the greenhouse (Paparozzi & Meyer, 2012).

Water conservation

Roof runoff would be stored in rain storage tank and used for drinking, cooking, and washing. The students used a Water Consumption Calculator to find the annual water consumption (CSG Network, 2012). Since the estimate of collectable roof runoff is below demand, the balance of water needed would come either from savings in use or using the existing mains water connection (Figure 12).

Healthy indoor air

Discussions revolved around natural lighting, ventilation, and eliminating building materials containing toxic substances to achieve healthy indoor air.

During consolidation sessions, desktop calculations were carried out for each room to estimate the natural lighting and found it meet the terms of the UK Department of Environment, Transport and Regions' Guide (1998) and the New Zealand Standards (AS/NZS 1680.1, 2006). In terms of ventilation, the existing net opening areas fell within the New Zealand Building Code for ventilation requirements (Department of Building and Housing, 2011).

Low or no volatile organic compound (VOC) paints would be used throughout the project. Studio discussions were based around students' findings on set VOC levels. Durable and formaldehyde-free wood-based materials and products were chosen for new and retrofit components. Studio discussions focused on the effects of formaldehyde as a carcinogen.

Judging the design concepts

The design concept stage of the project brief was completed and six concepts were put on display (Figures 6 and 7). In order to achieve impartiality in selecting the concept to take to the next stage, the submissions were judged by an independent team outside the teaching staff. This was a panel of an architect with experience in designing sustainable buildings, the Head of School of Arts and Design (now the *ideaschool*©), and the building development officer at EIT. After examining the submissions, the panel could not decide on a clear winner but opted to select favoured elements and particular solutions from individual concepts in order to form a *combined design concept* (Figures 9, 10, 11, and 12). In their feedback report, the panel provided recommended criteria for the combined design concept, summarised as follows:

- to be mindful of the history of the place and site,
- to fully utilise what previously exists of the LC,
- to maintain the integrity of the LC structure,
- to ensure multiple reasons for any proposed design decision, and
- to pay further attention to rationalising building services.

PROJECT DESIGN DEVELOPMENT

The outlines of the combined design concept were decided by the group. Stage 3 of the project brief started with each student assigned a particular part of the combined concept to explore and develop in further detail. The six topics were passive solar design, the proposed greenhouse, the kitchen retrofit, the proposed bathroom, and the interior space retrofit, and external works including wastewater treatment, water conservation, landscape, and exterior ground works.

Each student addressed key design targets related to their assigned task and produced a number of solutions to fulfil the criteria of the project brief. The results showed a developing sensitivity towards defining and executing the design ideas, while showing consideration for the intentions of the combined Stage 2 concept. The results arrived at by the students were specific to the LC's particular situation.

For the development work, the studio delivery pattern and its associated learning strategy and learning contexts used in the earlier stage were repeated here.

Six months after the end of the LC design project, a post-engagement focus group interview was undertaken with an added question on the actions they might have performed as a result of taking part in the project.

Project refurbishment working drawings

The student's design work was compiled by the author to form the basis for a set of working drawings and project specifications. All the necessary measures were taken to ensure compliance with the New Zealand Building Code. A building consent application was made to Napier City Council and a building permit later issued to authorise the building works.

STUDENT DESIGNER FOCUS GROUPS

Two focus groups were conducted with the student designers, pre- and post-engagement.

Pre-engagement focus group analysis

The aim of the first focus group discussion was to establish a benchmark of the participants' understandings of, and concerns for, environmental issues before engaging in the project.

Participants and procedure

A focus group was conducted with the six student designers prior to their involvement with the design stage of the project. The discussions explored responses to a two-part question: *How concerned are you about the harm that humans are causing to the environment? Looking ahead to the year 2050, are you concerned about the consequences of environmental problems in relation to each of the following clusters: the biosphere, yourself, and other people.* The second question was based on Schultz's (2001) three clusters of environmental attitudes related to environmental concerns. These are egoistic (me, my health, my lifestyle, and my future), altruistic (all people, children, my children, and people in New Zealand), and biospheric (plants, marine life, animals, and birds). This type of question has been used before in New Zealand, so the results can be compared with other studies (Milfont, 2007, pp. 32–34). The focus group session took place in a lecture room at the EIT campus. An hour was set aside for discussion. The author was the only non-participant present and the discussion was recorded. The student participants contributed to the discussion in varying degrees.

Data analysis

Analysis of the data to identify recurrent themes was based on the *thematic analysis* guidelines (Braun & Clarke, 2006). The recorded data was first transcribed. Quotes were then extracted and each referenced to the time the comment was made at the focus group. All quotes in the discussion below were extracted verbatim from the transcripts.

After becoming familiarised with the data, an initial list of codes was generated from the various topics brought up by the students (Braun & Clarke, 2006). This was done across the data set, rather than for each question individually in order to identify commonalities running through the data. Working from the perspective of environmental attitudes, the aim was to find out why individuals chose to be involved in the project as part of their education at EIT. To achieve this, repeated rounds of reading and categorising the data led to the emergence of broad themes, and specific sub-themes within these, all derived from the data (Braun & Clarke, 2006; Boyatzis, 1998). An ***initial*** thematic map was prepared. The themes identified were "the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon" (Boyatzis, 1998, p.63). These were then reviewed and refined through repeated investigation both of pattern and commonality to create a ***developed*** thematic map (Braun & Clarke, 2006). Direct quotes from the transcripts were grouped under similar thematic headings to provide a clear illustration of each theme in the participants' own words, and to give an indication of the number of participants who addressed each theme (or sub-theme). From this, a ***final*** thematic map emerged. While frequency is not necessarily a measure of significance, it offers a sense of the extent to which a particular experience was common across responses, and so the extent to which it might represent a shared understanding, or agreement with others.

RESULTS

Consequent to review and refinement, three main themes emerged (Figure 13):

1. support for responsible environmental behaviour,

2. the need to be environmentally motivated, and

3. concerns about the future as result of human activities.

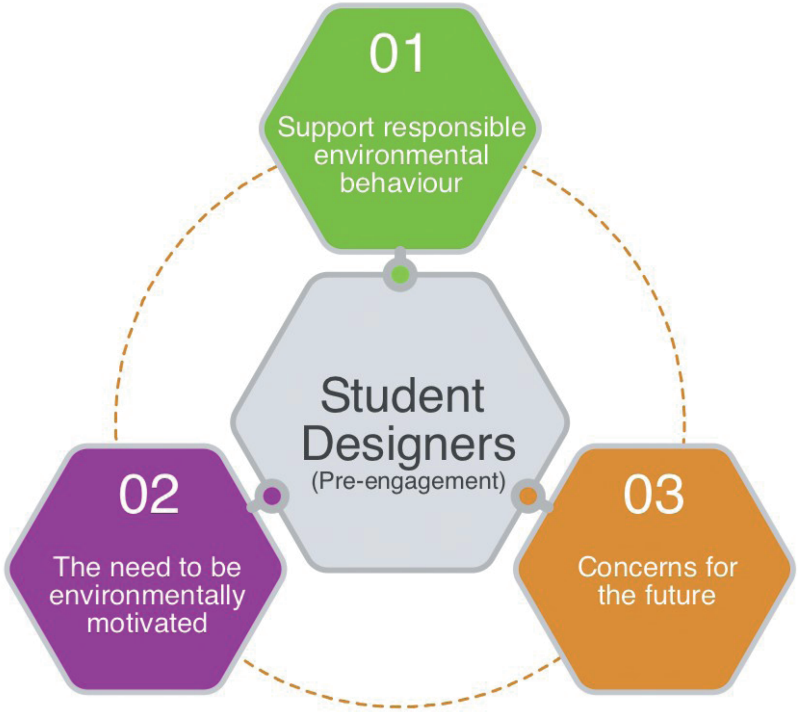

Figure 13. Final thematic map from the student designer pre-engagement focus group themes

These three main themes are discussed below individually.

(1) Support for responsible environmental behaviour

The students stressed the importance of living sustainably with an emphasis on health, valuing sustainable living patterns, and being in an ecological and organic living environment. There was a notable call for nurturing responsible environmental attitudes in the community through inspiring the behaviour of others, supporting environmental actions, and being passionate about animals and ecosystems. Concerns for environmental behaviour ranged from concerns for self (health and nutrition) to taking a wider view that could still incorporate self (concern for organic living environment).

(2) The need to be environmentally motivated

The students highlighted the importance of environmental motivation through discussion and practice at the various levels of self, family, and community. There was also emphasis on the need to acquire in-depth environmental knowledge. They saw involvement with the LC project as an opportunity to focus beyond basic ecological knowledge and issue awareness (Hungerford & Volk, 1990). They also stressed communicating information, including the role of the media.

(3) Concerns about the future as a result of human activities

All participants shared a sense of concern and a degree of pessimism when it came to envisioning the future of the world, due to general concerns about rapid population expansion and increasing demand for materials placing stress on space and resources. Students felt this could result in adverse consequences and environmental problems for the future of the planet and its ecosystems. The importance of preserving natural capital for current and future generations was also emphasised. Furthermore, the contemporary consumerist culture of obtaining more and more material possessions was perceived as putting extra pressure on resources and causing an increase in the gap between rich and poor.

DISCUSSION

For a qualitative analysis, the group of six participants is small, however the level and type of information extracted was focused, rich, and diverse. The open-ended questions allowed participants to communicate their own experiences in their own words. As such, the themes identified reflected the spontaneous use of common terms and offered powerful evidence of shared ideas on what it means to be sustainable in New Zealand today. Moreover, observations of commonly experienced reactions to unsustainable practices suggested the participants had strong passion, motivation, and intention to be sustainable, and some would also try to influence others to behave sustainably and be ecologically responsible. It also offered an insight into why this group of individuals became involved in the project. Reactions to the two-part question showed the need for in-depth knowledge about sustainable topics and practices so the students could feel confident in taking ownership of environmental issues and subsequently use this knowledge to empower others to hold sustainable values and know of environmental action strategies. The analysis offered qualitative evidence for basic understanding of self, others, and the biosphere in relation to social, environmental, and economic platforms, and that the students had the knowledge and intention to act sustainably. Further, it added to the claim that green practices are also political, rather than just being issues of personal interest.

Post-engagement focus group analysis

A post-engagement focus group discussion was conducted with the same group to compare data and look for any effects that might be linked to having been involved in the LC project concept design.

Participants and procedure

This focus group was conducted with five of the participant students six months after their involvement with the LC project concept design. Having moved to another town, the sixth student was not available although a similar interview was arranged at a later date. The thematic analysis uses data from both the focus group and the interview. Both sessions aimed to explore responses to the same questions posed in the first focus group: *How concerned are you about the harm that humans are causing to the environment? Looking ahead to the year 2050, are you concerned about the environmental problems in relation to each of the following valued object groups: the biosphere, yourself, and other people.* In this post involvement discussion, an additional question was asked: *Did the experience of being involved in the design of the LC project affect the way you acted recently in relation to sustainability?*

The focus group with the five student designers took place in a meeting room at the EIT campus, while the meeting with sixth student was in the library. An hour was allocated for both. The author was the only person present in both meetings and both discussions were recorded.

Data analysis

Thematic analysis was also used to identify recurrent themes in the data (Braun & Clarke, 2006). The process adopted was similar to that explained above.

RESULTS

Upon arriving at a satisfactory thematic map of the data, the dominant themes were organised (Braun & Clarke, 2006) (Figure 14). This produced three main themes, which are discussed below:

1. willingness to enable environmental practices;

2. having the motivation to support environmental actions; and

3. seeking in-depth and ongoing knowledge of environmental issues.

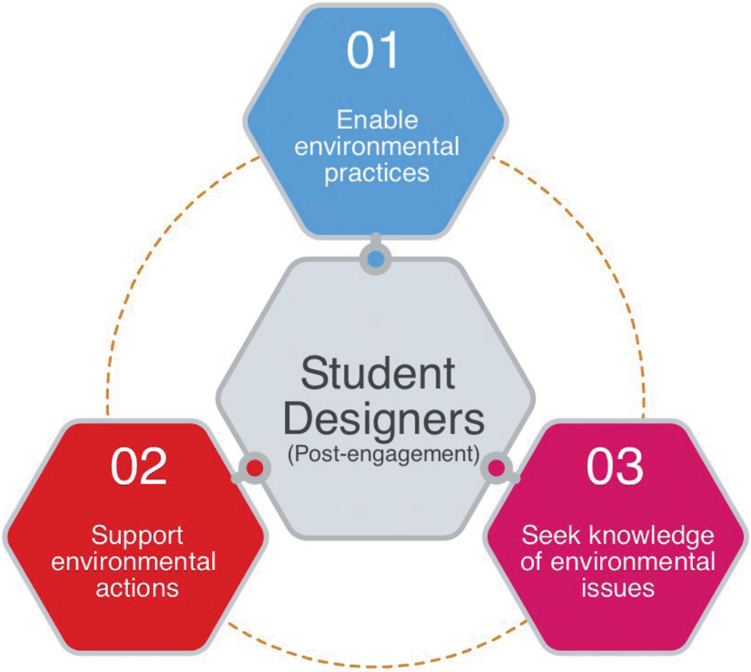

Figure 14. Final thematic map from the student designer post-engagement focus group themes

(1) Willingness to enable environmental practices

The students stressed the importance of using energy and other natural resources responsibly, and were motivated to choose sustainable options in spite of cost, at least at times. The participants were also keen to acquire in-depth knowledge of the effects of environmentally harmful food growing and processing practices.

(2) Having the motivation to support environmental actions

Post involvement in the LC project, a number of students tried to convince those close to them to act in an environmentally responsive way. They showed willingness to support others make environmentally sound decisions and assist them to change their environmental behaviour, thus demonstrating ownership and empowerment qualities (Hungerford & Volk, 1990). As evidence of this, students highlighted the importance of supporting and educating others to act sustainably, being self-motivated in pursuing environmental initiatives, and encouraging others to adopt sustainable practices.

(3) Seeking in-depth and ongoing knowledge of environmental issues

The students asserted the significance of continuously pursuing knowledge about matters related to ecology and the environment. This included the ability to define the characteristics of a sustainable practice, the ability to recognize the need to extend personal knowledge of environmental issues, and the hope their knowledge could be applied in new and emerging job opportunities related to sustainability. They highlighted the significance of conservationist living patterns.

DISCUSSION

Interviews with the students who chose to be involved in designing the LC project highlighted the significance of living sustainably, valuing ecological and organic living practices, stressing the importance of using energy and other natural resources responsibly, and being motivated to choose sustainable options in spite of cost, at least at times. The participants were keen to acquire in-depth knowledge about environmental matters, particularly focusing on the effects of non-environmentally harmful food growing and processing practices.

Subsequent to their involvement in designing the LC, the student designers' passion for supporting and educating others to act sustainably was observed. They were self-motivated to pursue environmental initiatives, and realised the significance of encouraging others to make environmental investments. The discussion revealed a number of instances where participant students demonstrated active pro-environmental behaviour, such as convincing a close friend to invest in purchasing photovoltaic technology for a lower electricity bill in the face of reduced income and more time at home after retirement. This demonstrated strong pro-environmental intentions and awareness of adverse consequences (Joireman et al., 2001). Another student concerned about health and nutrition, encouraged flatmates to start looking at the ingredients as a guide to food product choices, showing social altruistic concerns (Schultz, 2001). A third student offered to help friends establish a social media network page to exchange information on environmental and health interests, demonstrating ascription of responsibility beliefs (Stern et al., 1999).

CONCLUSIONS

The paper discusses how the LC project was set up and the reflective process of establishing a framework for retrofitting the building to become a demonstration project for sustainable construction and a facility to inspire responsible environmental behaviour. It describes the involvement of a group of students at EIT and how it went about creating a brief and design concepts for the building. It also demonstrates a process for helping the students look at standards and extract design criteria that suit this specific project in terms of building sustainability, given the wide body of knowledge about what a sustainable building might be. This paper also investigated whether this engagement has influenced their environmental values.

Reflecting on the teaching process, the focus on retrofitting an existing building and outlining specific aspects of sustainability that were then set in the aims and parameters, meant that each one needed to be understood, discussed, and applied successfully. The students were engaged and motivated by the power of the context: sustainability. The learning occurred actively and the teaching of design and environment -related principles was delivered side-by-side with the development of skills and their application. Emphasis was on facilitated learning rather than instructive and the structure challenged students to engage in a proactive manner in order to gain deeper understanding. The development of knowledge of design and the ability to design were demonstrated through: firstly, the project design work, which integrated individual aspects of dealing with independent components of the context and the whole process of evolving a workable final design proposal; secondly, the level of complexity embedded in the project outcomes and the evaluation and integration of a wide volume of knowledge, the latter guided by the project brief; thirdly, the ability to communicate ideas and solutions, and the ability to work as a group to deliver an effective mode of representation for the project concept at different stages of the process; and finally, the level of engagement of all six student designers in the LC project demonstrated developing generic and specific knowledge, and exhibited a passion for the subject, together with critical thinking, reflection, and the ability to integrate and apply different concepts at a level appropriate for Second Year undergraduate students.

This research used the process of designing and retrofitting a sustainable project to investigate the values held by those who did elect to become involved in the process. As might be expected, people chose to be involved with the LC project for various reasons. However, pre-engagement studies showed that those who became involved tended to have at least a heightened awareness of sustainability issues and for some students, values and attitudes that reflected this interest. The latter included a willingness to adopt sustainable practices, appreciate ecological and organic living methods, and support the responsible use of natural resources. The project's context of converting a near-derelict existing building to being a sustainable one was also important in inspiring individuals to do something tangible and beneficial for both sustainability and the local community. In general, those who chose to engage with the project expressed a passion for nature, culture, and ecology, as well as having the intention to act.

The student designers seem to have been affected by their experience of and knowledge gained through the LC project design by quickly taking steps towards acquiring and adopting environmental values with passion. The students took ownership of the project and worked enthusiastically with developing awareness of sustainable building methods and concern for ecological living practices. Post-engagement interviews demonstrated an evolving responsible environmental behaviour in valuing ecological and organic living practices, and stressed the sensible use of energy and other natural resources, and often opting for sustainable choices despite the cost. Individually, students also developed skills for investigating and evaluating environmental options, particularly living and diet options, and using new media platforms for communication. Consequent to their involvement in the design of the LC concept, student designers demonstrated intention to take sustainable actions. Armed with environmental knowledge, the students were motivated to pursue ecologically inspired initiatives, both at a personal level and in empowering others to adopt sustainable actions.

Commenting on the relationship between design and sustainability, Chapman (2009) stated, "The sustainability crisis is a behavioural issue, and not one simply of technology, production, and volume.

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