

## A PROJECT-BASED LEARNING APPROACH TO SUPPORT GREEN BUILDING EDUCATION

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### ABSTRACT

*This paper presents the design, implementation and evaluation result of a project-based learning-led hospitality real estate management course of a master programme in Hong Kong. In order to raise students' environmental awareness, the course was designed based on a pedagogical model that incorporates four types of teaching methods to support project-based learning. In this course, students are allowed to attend lecture-based teaching, a virtual site visit to the CIC-Zero Carbon Park, a physical site visit to a green hotel, followed by accomplishing a practicum-based project. To measure the effectiveness of the course delivery, feedbacks from both green building professionals and the students of the course were collected. The analysed results reveal that the course was able to cover the intended green building lifecycle knowledge and provided the students with positive learning experience; furthermore, the dynamic structure of the course enhanced the students' interest in fostering green buildings.*

Keywords: green building; pedagogical model; project-based learning; site visit; virtual reality

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## 1. INTRODUCTION

Activities in buildings account for more than 90% of electricity consumption and 60% of greenhouse gas emissions in Hong Kong (HKGBC, 2021). In order to enhance the public's environmental awareness, the Hong Kong government has designed various incentives to facilitate environmental education (Liang et al., 2019), of which green building education is an essential component. At the higher education level, especially in the fields of civil engineering, architecture design, real estate development, construction management, business development and hospitality management, green building education plays a key role in curriculum design (Cole and Altenburger, 2019). The knowledge of green building spans the entire life cycle of buildings (Lai and Yik, 2006). Not only is it essential for professionals involved in feasibility studies (e.g. economic cost-benefit analysis), planning, design and construction, but those responsible for facility management (including building operation and maintenance (Lai, 2010)) need to be equipped with green building knowledge.

To enable students to learn knowledge related to hospitality real estate asset planning, design, construction and management, a course entitled "facilities development and management" within a hospitality real estate programme was designed. It has been delivered as a mandatory post-graduate course (MSc in Hospitality and Real Estate Asset Management) in the hotel school of a university, under the Faculty of Business Administration. As sustainable practice becomes more quintessential in both hospitality and real estate industries, it has been taught under some lecture topics of the business school curriculum. Yet it has not been systematically incorporated into the course design. Initiated by the intention to further strengthen green building knowledge in the programme's curriculum, this course embraces a project-based learning approach to facilitate students to learn contemporary green building knowledge. Furthermore, this course adopts virtual reality (VR) technology to develop a package of virtual site visit as the teaching materials to support students' learning activities.

During the course implementation process, five green building professionals were interviewed to provide feedbacks on the course design. Also, student feedbacks were collected and analysed. In the following sections, a project-based learning-led pedagogical model developed to guide the course design will be explained; the course implementation process will be elaborated; and opinion-based data collected from both the green building professionals and students will be reported and discussed. Lastly, conclusions drawn from the study will be provided.

## 2. A PROJECT-BASED LEARNING PEDOGAGICAL MODEL

The design of real estate or hospitality curriculum usually contains both theoretical knowledge and practicum, which are considered to be able to implementing each other to reinforce students' understanding of the knowledge of the industrial principles and practice. However, the two elements – theoretical knowledge and practicum are usually not integrated in one course due to a lack of systematic pedagogical support.

Examining the learning objectives of the course is prerequisite for pedagogical methods selection in the process of course design (Hou and Wu, 2020). The objectives of this course include: to deliver knowledge of the design, construction and operation stages of hospitality real estate; to enable students to master professional skills in conducting market research, monitoring the planning and development process, and operation management; and to foster students to develop critical thinking and problem-solving skills. Project-based learning (PBL) is regarded as an appropriate pedagogical method to integrate both theoretical knowledge and practicum in a hospitality real estate curriculum and it allows green building knowledge to be embedded in the course content.

PBL is a student-centred pedagogy with the aim to engage learners in knowledge construction along with the process of completing assigned projects that mirror real-world practice (Guo et al., 2000). It has been increasingly used in engineering and construction management education settings with integration of technologies as a supporting tool (Goedert et al., 2013). This pedagogical method allows students to complete a number of small tasks at different stages of the learning process and the scenarios of the tasks are designed based on industrial practice (Liu et al., 2010). Knowledge intended for PBL is delivered through different learning activities on a task basis and the instructors play a facilitator role during the learning process. Furthermore, PBL pedagogical method has been widely applied in many education cases. In some cases, the use of cognitive tools is added into a PBL model to facilitate students' cognitive learning process (Krajcik et al., 1994; Marx et al., 1994).

In this study, a pedagogical model was designed with incorporation of green building knowledge using PBL pedagogical method. The model consists of a four-stage learning process, in which students are required to complete a series of tasks that lead to the completion of a final project. For knowledge construction, the students are required to participate in four stages of activities, including lecture-based learning, a virtual site visit, a technical site visit and a practicum-based project delivery.

### **3. COURSE DESIGN**

#### **3.1 Stage 1 - content development and lecture-based teaching**

In order to achieve the learning objectives, the course contents were designed based on the knowledge of hospitality real estate development process, which included concept development, feasibility studies, planning and financing, project construction, and operation (Stipanuk and Roffmann, 1992; Ransley and Ingram, 2012). Green building knowledge was then selected and integrated under the development stage. For example, under the stage of “concept development”, green building knowledge such as green building concept, green building rating and certification systems, and benefit of green buildings are covered; for “feasibility studies”, students learn basic real estate feasibility analysis including market analysis, site assessment, environmental impact assessment, development pro forma, and development team establishment. On top of this, green building knowledge such as cost-benefit analysis for green building development, sustainable site, land use and ecology, liveable community, and corporate social responsibilities are covered. The knowledge pack is delivered by the instructor on a classroom-teaching basis.

Furthermore, the practicum project was designed in advance and its requirements are explained to the students in the first class. Students are expected to utilise the knowledge learned from lectures and site visits to complete the project on a group basis.

#### **3.2 Stage 2 - virtual site visit**

A virtual site visit is organised in the second stage. As only 15 VR glasses are available, students are divided into two groups to participate in the virtual site visit. The VR video supports both 2D version and 3D version of viewing. Students can view the 3D version with the support of VR glasses. During the virtual site visit, students were asked to view a VR video that features the CIC-Zero Carbon Park (CIC-ZCP) in Hong Kong. Serving as an exhibition centre, an education centre and an information centre for zero/low carbon building design and technologies as well as promoting low carbon living in Hong Kong, the CIC-ZCP showcases the state-of-the-art eco-building design and technologies to the local and international construction industry (ZCP, 2021).

The VR video was developed by the instructor with the support of a university courseware development grant. It consists of a series of 360-degree photos integrated with a number of functions, such as navigation, path selection, voice-over, and image pop-up. For the voice-over function, students can “select” to hear the embedded illustration on the green features of the ZCP; for the image pop-up, students can “select” to view the illustrative texts or the embedded zoom-in photos for a closer observation of the green features.

#### **3.3 Stage 3- technical site visit**

In this stage, a technical site visit at a building certified under LEED premium is organised to enable students to observe the building characteristics and the on-site management practice. Managerial staff of the green building provide in situ tour guide service. During the tour, students can observe the features of the green building in person and ask questions about the green management practice of the building.

#### **3.4 Stage 4 - practicum project**

In this stage, students are required to present their tasks required by the practicum project on a group basis. Each group is required to submit a project report and was allowed to have 15 minutes to present the content of their report followed by a five minutes Q&A. The evaluation of their reports was based on the following requirements:

- Clearly indicating the concept of the green real estate development project

- Conducting market research with both first-hand and second-hand data to justify the business concept and design concept
- Reporting the results of the financial and physical feasibility studies
- Delivering an architectural design layout and functional design layout of the green real estate
- Developing marketing strategies and a management plan for the building operation after the grand opening

#### 4. COURSE IMPLEMENTATION

The course consists of 13 lectures in total (one lecture per week) and each lecture lasts 2.5 hours. In the first lecture, students were randomly allocated to a number of groups, with maximum 6 students in each group. The course was delivered based on the PBL pedagogical model.

The first six classes were arranged in the form of traditional lecture-based teaching. An overview of the course structure and the detailed instruction of the practicum-based project was introduced in the first lecture. From week 2 to week 6, five lectures focusing on different topics of the hospitality real estate development process were delivered.

For weeks 7 and 8, two sessions of virtual site visits were organized. As only 15 VR-glasses were provided, the virtual site visits were organized twice and students were randomly assigned to either session. After the virtual site visits, the instructor adopted the CIC-ZCP as a case to elaborate the development process, green design features and green building management strategies.

For week 9, a technical site visit to the Holiday Inn Express Hotel Soho (HIEHSh) was conducted. HIEHSh is a green building received a number of accreditations by international green building association, such as LEED-NC Platinum awarded by LEED, BEAM-plus by HKGBC, Green Mark's Provisional Platinum by Green Mark Singapore. The building itself has demonstrated the state-of-the-art green building knowledge in the building development life cycle. The technical site visit was guided by the General Manager of the HIEHSh and a guest lecture was given by him at the hotel conference room. Students were allowed to witness the operation of a green building as well as green management practice during the site visit. They were encouraged to communicate with the General Manager in person to acquire management knowledge of a green hotel. In week 10, an exam was arranged to assess students' knowledge of real estate development as well as green building development.

A reflection lecture was delivered in week 11 to summarise the knowledge learned in the previous lecture, in which students were given detailed instructions to produce the final project work. In the last lecture, students took turn to present their project work on a group basis.

#### 5. INTERVIEWS WITH GREEN BUILDING PROFESSIONALS

Interviews with green building professionals were conducted to understand their opinions on the course design. The brief profile of the five green building professionals is illustrated in Table 1. The five professionals have previous experience in green building development.

**Table 1.** Brief profile of the interviewed green building professionals

Interviewee	Job title	Organisation
A	General manager	Hotel <sup>1</sup>
B	Director in Engineering and Sustainable Practice	Hotel
C	Architect	Architectural firm
D	Facilities Manager	Real estate developer
E	Green Building Accreditation Scheme Accreditor	NGO <sup>2</sup>

<sup>1</sup> The hotel is certified with LEED Platinum

<sup>2</sup> Non-government organisation

The interviewees were selected based on a purposive sampling method. Green building professionals who had experience in collaboration with higher education course or development delivery (e.g. guest lecturer, education programme accreditation, etc.) were invited to participate in the interviews. Five interviewees

accepted the interview invitation. During the 45-minute interview, each interviewee was asked to share their perception on (1) the role of green building education in higher education curriculums, (2) the integration of green building knowledge in a hospitality real estate programme, and (3) the course design based on a PBL approach.

All the five interviewees regarded that in general, green building education has not been effectively delivered in hospitality programmes at the higher education level in Hong Kong. Green building education is a compulsory component in building science related education programme, such as civil engineering, building engineering, architecture, real estate, construction, environment management, geography, etc. Interviewee A expressed that the course curriculum can enable the students to learn building components, green building design principles and sustainable practices, such as energy saving. Interview B believed that the curriculum can enhance students' knowledge of building environment. Interviewees C and D suggested that the curriculum can be adopted for designing a general education course to be opened for all the university students to select. They believed that universities are responsible for disseminating green building knowledge through general education courses. They also shared one type of green practice in secondary schools in Hong Kong: the existing teaching blocks of some secondary schools were refurbished according to certain green building standards and have been certified with the green building scheme in Hong Kong.

Regarding the second question, five interviewees held a very positive attitude towards the idea of incorporating green building education in hospitality real estate programmes. They believed that green building knowledge shall be effectively delivered to future professionals who work on projects in the built environment. Interviewee A suggested that the built environment, especially hotel rooms, are part of the "service package" delivered to the hotel guests; thus, all hoteliers shall develop a better understanding of hotel buildings and a sustainable way to manage them. Interviewee B revealed that aside from managing the engineering facilities of the hotel building, he is also responsible for organizing corporate social responsibilities (CSR) practice, including waste recycling, beach cleaning, food donation, etc. He argued that green building management is an important part of a hotel's CSR practice and therefore, young hotel professionals should be taught about both "hard" and "soft" sustainable practice. By "hard" sustainable practice, he meant green building knowledge. For "soft" sustainable practice, he referred to "green hotel practice" (e.g. waste reduction and recycling). Interviewees C and D regarded hotel as part of real estate, and the operation management of a hotel highly resembles that of an office building or a shopping centre. Interviewee C has been committed to promoting green building education to the general public and he showed a high level of support in teaching green building knowledge to students from a hospitality real estate programme.

After the first two questions, the interviewer explained the course design and how green building knowledge was incorporated into the course by topics on a PBL basis. The interviewees were asked to share their opinions regarding the course design. All the interviewees believe that the final project has driven the students to proactively pursue knowledge and facilitated the students to develop problem-solving capabilities. Interviewee A suggested that hospitality students should be equipped with hands-on knowledge, which can support them to handle tasks at both operational and managerial levels in their future career; a final project demanding building life-cycle knowledge would help students to understand built environment-human-relationship and the principles of organising business activities in certain built environment-human scenarios. Interviewee B also suggested that PBL can systematically and effectively weave the knowledge learned from each lecture together to support the final project-based task; this approach facilitates students to complete the tasks by considering the "big picture" / the whole life cycle of a building; also, the PBL approach is a good way to unleash students' potential in management activities in the future. Interviewees C, D and E provided positive comments on this approach, suggesting that this approach simulates the actual practice in the real world and students can apply the textbook knowledge to project work.

## **6. STUDENT FEEDBACK**

At the end of the course, students were required to complete a teaching evaluation survey to assess students' perception towards the course.

The survey was designed based on a 6-point Likert scale with the minimum and maximum levels of agreement on the criteria items being 1 and 6 respectively. The assessment evaluation criteria include 18 items and 10 of them are relevant to course design and implementation, namely, presentation is clear, examples relevant to learning, class participation encouraged, communication was effective, clear learning outcomes, the course is

well-organised, the course was stimulating, the course was interesting, subject knowledge is enhanced, satisfaction with course. Table 2 illustrates the mean values of the students' agreement level of the 10 items.

The class size was 60, with 53 responses given to the survey. According to the survey results, students' overall satisfaction level with the course is above average (mean: 5.67). The ten items received equally high rating from students, with all of the mean values above 5.5. Among the 10 items, "class participation encouraged" received the highest rating, whose mean value is 5.78, followed by "communication was effective" (mean: 5.76). "Presentation is clear", "examples relevant to learning", "clear learning outcomes", "the course is well-organised", and "subject knowledge is enhanced" received similar ratings (mean values from 5.62 to 5.69) from the students. The only item with a mean value lower than 5.60 is "the course was interesting" (mean value: 5.51). Although this mean value is lower than those of the other items, this item was still rated quite high by the students.

**Table 2.** Course and teaching evaluation for the course

	Mean (%)	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
Presentation is clear	5.62	0	0	0	0	4	49
Examples relevant to learning	5.66	0	0	0	1	4	48
Class participation encouraged	5.78	0	0	0	2	7	44
Communication was effective	5.76	0	0	0	1	3	49
Clear learning outcomes	5.64	0	0	0	2	12	39
The course is well-organised	5.62	0	0	0	4	8	42
The course was stimulating	5.56	0	0	0	2	10	41
The course was interesting	5.51	0	0	0	3	12	38
Subject knowledge is enhanced	5.69	0	0	0	0	10	43
Satisfaction with course	5.69	0	0	0	0	7	46

Furthermore, the ten evaluation items can be divided into four categories: 1) students' perception on the lecture-based teaching performance; 2) students' perception on the course content and activities design, 3) students' self-perception of learning effectiveness and 4) overall satisfaction (Table 3). A mean value for each category was computed based on the mean values of the items in the respective category. The category mean values indicate that students' perception on the lecture-based teaching performance is the highest while students' perception on course content and activities design is relatively low.

**Table 3.** Categories of the evaluation items

Evaluation item	Categories	Category mean	
1 Presentation is clear 2 Examples relevant to learning 3 Class participation encouraged 4 Communication was effective	Students' perception on the lecture-based teaching performance	5.71	
5 Clear learning outcomes			5.58

6	The course is well-organised	Students' perception on the course content and activities design	
7	The course was stimulating		
8	The course was interesting		
9	Subject knowledge is enhanced	Students' self-perception of learning effectiveness	5.69
10	Satisfaction with course	Overall evaluation	5.67

## 7. CONCLUSION

This study adopted a PBL approach to develop a pedagogical model to support green building education in a hospitality real estate course. The model elaborates the components of the course design and their relationships with the PBL pedagogy. It was implemented based on a hospitality real estate course and the implementation process has been presented. A number of five green building professionals were interviewed to understand the learning effectiveness and education implication of the model. Furthermore, the results of a centralized course and teaching evaluation survey were used to analyse the students' feedback on the course design and their learning outcome. Both the professionals and the students offered positive feedbacks; particularly, the students provided a high level of acknowledgement by giving high rating scores in the survey.

The pedagogical model developed based on the existing hospitality real estate course is considered to be novel. The results of the interview and the teaching evaluation survey confirmed the effectiveness of pedagogical model. Meanwhile, implementation of the model requires the course designer or instructor to fully comprehend two sets of knowledge bodies in order to deliver effective learning activities and teaching materials design. It is foreseen that more pedagogical elements can be integrated in the developed pedagogical model to support green education design.

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