

Lighting Design by Computer Software in Teaching and Practice: A Case Study in Vocational Training of Interior Design [†]

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Abstract: This study aims to compute the display of indoor lighting and compare the performance of different lighting simulations. Students of the two-year vocational training program participated in this study to improve the quality of lighting design and understand lighting simulation programs. The participants learned how to construct 3D models for lighting analysis to acquire the necessary vocational skills. The teaching outcomes of four years were summarized to identify barriers in technical communication. Challenges that teachers face when teaching interior design were determined through discussion to communicate professional skills that were mismatched in teaching and learning. Suggestions were made on how to improve the effectiveness of learning and the quality of teaching in vocational education in online classes.

Keywords: lighting design; lighting simulation; vocational training



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1. Introduction

A two-year program has been in operation for about 40 years in Taiwan to meet the needs of the young to learn manufacturing and management skills. A few private universities offer such vocational training courses for foreign students according to their abilities. A university in Hsinchu City has developed the Overseas Youth Vocational Training Program (OYVTP) to offer training in various areas. The two-year vocational training courses are adjusted according to the blueprint of the 1st and 2nd years of the Department of Architecture and Urban Planning (DAUP). In terms of cultural literacy, students are familiar with the traditional culture of the East, but their mother tongue is different. Most Chinese students from Malaysia can communicate without barriers. However, for students from other countries, Mandarin is not used, and even English cannot be an alternative. This is challenging for tutors. In this study, indoor lighting was selected as a topic to teach as it demands technical communication to make students understand. Before the advent of computers, the only way to represent the effect of light was to use a model. With the development of digital imaging, various analyses can be presented with hyper-realistic images.

2. Methodology

The DAUP of the school has offered the OYVTP class since 2017 at the College of Architecture and Design. 16 lecturers are responsible for the students each year. The average number of students per year is 20, and the ratio of male to female students is 3 to 1. Table 1 presents the status of students in the OYVTP class in the department.

In addition to exploring the competencies required for the interior design profession and the effectiveness of vocational education, this study was carried out based on pedagogical or structural transformation. In this study, the Focus Group Discussion (FGD) method was used in interior design. A review was conducted to clarify the study's findings

and highlight ideas from experts. In addition to learning the necessary application tools, a satisfaction survey was conducted for students on the applications. It was necessary to optimize the training of graduates of design vocational schools with learning concepts relevant to the needs of the construction industry. Over the past five years, the computer graphics skills of foreign students have been discussed in the department. However, due to the small number of students, the enrollment of foreign students has been allowed since 2021. The university is considering ways to attract more vocational training students to pursue a degree at the university after completing 80 credits.

Table 1. Number of students in OYVTP.

Year of Enrollment (Class)	Total	Continued to Year 3	Transfer Rate (%)
2022 (41st)	16	12	75.0
2021 (40th)	18	12	66.7
2020 (39th)	25	17	68.0
2019 (38th)	0	-	-
2018 (37th)	14	1	7.1
2017 (36th)	16	1	6.3

Source: Office of International and Cross-Strait Affairs and DAUP, 2023.

2.1. Vocational Training and Academic Learning

DAUP is finding a way to absorb OYVTP students into university courses. There is a technical problem to be solved. In Taiwan, school starts in the fall, but OYVTP starts in the spring. The enrollment period for students starts in the second semester of the university. If they successfully study for two years of vocational courses and then enter the university, they need to enter the next semester of their third year. DAUP hopes that these students can change their learning attitude and complete architecture courses in one semester. Figure 1 shows the curriculum planning and progression path, which must be completed in the first semester. This program has been provided to students in the 39th class, after transferring to DAUP.

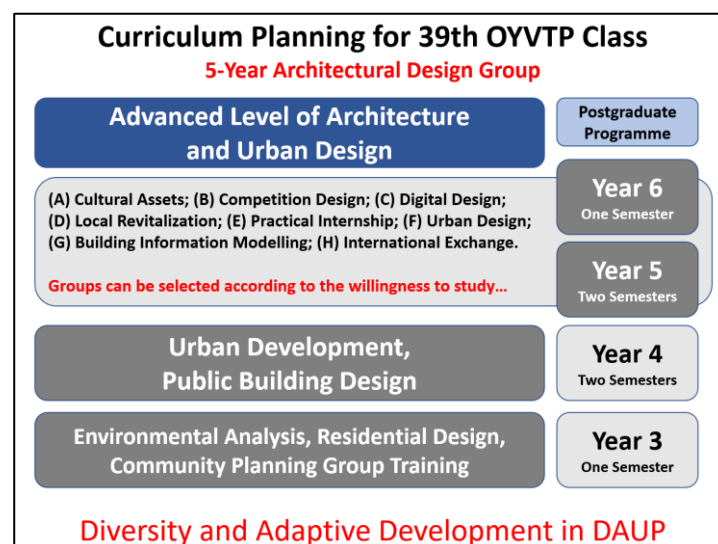


Figure 1. Curriculum planning for the 39th OYVTP students in the 5-Year Architectural Design Group. (Source: DAUP, 2021).

If six semesters are completed, the department encourages students to continue their studies at the Institute of Architecture. Thus, Figure 1 shows the postgraduate program (MARCH). It is not difficult to plan the course roadmap, but it is important to adjust the students' mentality. DAUP invited alumni learning architects for intensive training in

one semester. The design team of a company can take turns participating in the course and the short-term internship. This enables students to complement their theoretical and practical knowledge of architectural design as well as the concept of large-scale land and site planning. If this experimental arrangement is successful, it will help OYVTP students continue their studies.

2.2. Interior Design Training and Industry Prospects

Art design is an independent discipline, and its research content and service objects are different from traditional art categories. It involves society, culture, economy, market, and technology, and its esthetic standards change with these factors [1]. At the same time, interior design has living space as an object. It requires knowledge of engineering, technology, theory, and art skills. Interior design evolved from the decorative aspects of architectural design and is a recreation of the environment of the building [2]. Interior design is divided into two categories: public building spaces and homes. In interior design, important terms such as movement, space, color, lighting, and function are used. The design depends on creative activities and practices.

2.3. Job Skills

The main job of an interior designer is not easy. In addition to conforming to people's activities and habits, spiritual and esthetic functions need to be satisfied. Designers need to create an artistic conception, which requires talent and cultivation [3]. Therefore, in designing the interior, a designer needs to improve the interior space. The interior is a derivative of architecture [4]. The first thing the designer needs to do is improve the interior space and make the layout reasonable for convenient and comfortable living with complete functions. At the same time, it must be beautiful [2]. The layout must be reasonable, comfortable, convenient, beautiful, generous, and even luxurious. Each designer has new ideas and characteristics. However, for most interior designers, there are a lot of things to do. Interior designers' work includes the following:

- From conception, 3D modeling is necessary to provide complete design solutions, including physical environment planning, interior space separation, decorative image design, interior supplies, and complete configuration.
- Through creativity and design, the sense of space, practicability, superiority, and revolution of home design are demanded for humanization.
- The need to explain and plan creative ideas to coordinate with the decorating personnel.
- The need to coordinate and solve technical problems in the decorating process.
- The need to analyze costs and resources for interior decoration.
- The need to understand the development direction of the industry, from new processes and new technologies to innovative design.

These are also taught in the two-year vocational training courses. Students must obtain 80 credits in two years.

2.4. Industrial Prospects

At present, the rapid development of real estate and construction in mainland China has brought opportunities. The acceleration of urbanization, the prosperity of the housing industry, and the opening of markets make the real estate industry vigorous [5]. Design is the leader of the decoration industry, and the style of interior decoration is determined by design. According to the data of the relevant departments in mainland China, the number of talents that are in demand for interior design reaches 400,000 [6]. The graduates cannot meet the needs of the market in terms of quantity and quality. About a quarter of the graduates of DAUP went to mainland China. There is a demand for spatial design in emerging markets in East Asia, too. Students from Southeast Asia, after the two-year course, can practice at old building renovation sites. For reconstructing old buildings, manpower and financial and material resources are demanded, which allows interior design to have advantages. From a long-term perspective, the construction industry will not shrink as

intelligent buildings lead the construction revolution in the 21st century [7] as well as the development of other industries.

3. Lighting Design

Foreign students pursue their goals before coming to Taiwan. On the contrary, teachers at the university are not clear about their role in vocational training. In the sixth year, there are still embarrassing situations. At least half of teachers do not treat OYVTP classes as 4-year students. When it comes to creative design work, a lot of training intimidates students due to communication problems between teachers and students. DAUP has improved this situation, and since the end of 2018, full-time teachers have been assigned. The content of the lectures and the direction of the exercises must meet the requirements of interior design topics. At the same time, the teacher needs to hold regular meetings to track the progress of teaching. Based on the Focus Group Discussions (FGD) in the last three years, the three most frequently discussed topics were teaching, communications, and online teaching methods.

3.1. Learning Content

As all teachers have backgrounds in architectural design, they mainly teach spatial design. Therefore, in the course arrangement, students usually learn architecture. In practice, the master-apprentice teaching method of architecture is used [8]. Students are led by professional designers, and the way of learning is close to the work pattern in a design firm [3]. They behave as employees of the company to complete all the provided work according to the established process. They use presentation boards and scale models to present the interior design process. In addition to drafting, graphic design skills, including typography, color, and text styles, are necessary. In scale models, project display and practice are important. Students must understand details in interior spaces with larger-scale model implementations. Regarding the current requirements of interior design, basic skills are taught. Students are willing to improve their performance by learning the delicacy of the drawings and the meticulousness of the models [9].

3.2. Barriers to Learning

A set of long-term architecture or design training is expected to cultivate innovative or creative design talents [10]. In addition to the exquisite performance, the entire teaching team would like to observe the outstanding design work of the students. Therefore, in teaching or discussion, students are constantly asked to think and verify the best answer. Students think that a general plan can be completed with established progress. A lot of time and energy is spent on the preparation of architectural design drawings and model-making. In terms of the requirements, there is a gap between teachers and students. Normally, academic works of architecture pursue abstract spatial compositions. As long as students have outstanding ideas, even if the drawings and models are difficult, teachers do not mind much. However, if a student makes beautiful models or drawings without any personal design concepts or ideas, it is classified as ordinary work. The two years of vocational training are aimed at teaching skills quickly. Students can study as long as they have high school diplomas. Universities providing vocational training courses accept students in OCAC, so the relevant academic information cannot be obtained until the students submit the related documents.

3.3. Teaching Difficulty

In the Computer-Aided Design (CAD) course, the teaching materials in spatial and lighting are rich, and students' problems can easily be solved. The production of digital models is a demonstration of operating procedures, and the related content can be found on YouTube. Teaching lighting design is easy, but assignments are difficult to complete. Students need to understand the teacher's opinion. The CAD course coordinates the progress of the interior design class as follows:

- It refers to the substance of the interior design topic and confirms the date of the project review (Crit Day: the work of critique in interior design).
- During the CAD teaching time, about 20 min are provided to share wonderful interior design cases. The selection of cases is designated by the design tutors.
- Before a Crit Day, three cases are introduced, and one simple assessment is reserved. The content of the assessment is based on the cognition of design theory. The questions are created by the teachers of the design class.
- CAD teachers participate in reviews and grading. Generally, at least three teachers participate in the evaluation of the works.

The above practice has been implemented in DAUP's first-year Basic Design class. Given the shortcomings of the design class, equipment is used to conceive the design concept and practice the necessary drawing skills.

4. Application Tools

Interior design training needs a change in curriculum. It is important to have learning objectives so that students can grasp the key learning points and necessary skills in interior design. Lighting design for indoor environments is the most appropriate for professional training. Therefore, from the 39th class, the content and learning progress of the CAD program have been integrated into the design course. In design, the presentation of light is important. Based on the presentation of light in the space, students compare the renderings. Table 2 shows how the lighting tools match the design topics in DAUP. To learn these skills, the following lighting programs related to the visual system were selected as learning tools:

- AutoCAD: a 2D/3D CAD software application for desktop, web, and mobile developed by Autodesk.
- SketchUp: a 3D CAD program for a broad range of drawing and design applications.
- Revit: a BIM software for architects, landscape architects, structural engineers, mechanical, electrical, and plumbing (MEP) engineers, designers, and contractors.
- Kerkythea Rendering System: a standalone rendering system that supports raytracing and Metropolis light transport and uses physically accurate materials and lighting.
- Space Syntax depthmapX: an open-source and multi-platform spatial analysis software for spatial networks of different scales.
- Isovist: one of the two representations of the structure of space, along with the spatial-envelope representation. It is an approach to describing space from the point of view of a person within an environment.
- DIALux evo: to plan, calculate, and visualize lighting for indoor and outdoor areas, from entire buildings and individual rooms to parking spaces or road lighting.
- Radiance (with Ecotect): Using the libraries of materials, glazing, luminaires, and furnishings, realistic lighting models are created. Radiance is a design tool integrated with popular CAD packages to consider energy-efficient lighting and daylighting strategies in building design.

Table 2. Comparison of design topics and lighting design tools.

Semester	Spatial Types for Design Topic	Tools for Modeling and Analysis
1st (Year 1) Basic Design	Simple Booth Ideas (Gallery)	AutoCAD, SketchUp Pro, and Kerkythea Render
2nd (Year 1) Interior Design	Tiny House or Apartment (Residential)	Revit (BIM) with Solar Analysis, Space Syntax, Isovist, and DIALux evo
3rd (Year 2) Interior Design	Commercial Space (Business)	Radiance with Ecotect, Spatial VR, and Microsoft Azure AI
4th (Year 2) Thesis Project	Mixed-Use Property (Shophouses)	Isovist + DIALux evo + Any Renderers

5. Findings

41 students (39th, 40th, and 41st) responded to the questionnaire surveys at the end of the semester. The questionnaire was generated based on the concept of outcome-based learning and teaching approaches and recent practice. It contained eight closed-ended questions on a five-point Likert scale (where 1 was for ‘Strongly Disagree’ and 5 was for ‘Strongly Agree’). The questionnaire items included the following:

- Q1: Understand how the various applications work and the focus of the course training.
- Q2: The operation of the application is clearly explained.
- Q3: Have detailed feedback that is clearly explained during reviews or critiques.
- Q4: The study of lighting helps to reinforce the knowledge of design.
- Q5: You can use the tools you’ve learned as you do your homework.
- Q6: Be able to solve problems promptly.
- Q7: This course enhances students’ design ability.
- Q8: My abilities meet the basic requirements for employment.

Table 3 shows the average scores of students in the 39th, 40th, and 41st interior design classes. Students agreed with the current learning and training style. The scores ranged from 3.73 to 4.87. The students in the 39th and 40th classes showed an understanding of the course. Students were provided with adequate practical advice during interior design reviews or critiques (Q3, from 3.73 to 4.30). Students sought help with lighting simulations after classes (Q5 and Q6, from 4.22 to 4.82). Well-planned training and appropriate knowledge transfer were confirmed (Q7 and Q8, from 3.89 to 4.87). Students preferred the technical way of lighting design or simulations (Q4, from 3.81 to 4.04). Teachers also agreed that the quality of lighting applications needed to be strengthened.

Table 3. Average scores of students in 39th, 40th, and 41st OYVTP classes.

Class	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
41st	4.01	4.42	3.73	4.04	4.22	4.65	3.89	4.13
40th	3.97	4.11	3.88	3.96	4.39	4.23	4.21	4.02
39th	4.33	4.52	4.30	3.81	4.71	4.82	4.87	4.74

6. Conclusions

The importance of computer graphics skills in interior design was recognized to increase the enrollment of students pursuing a degree. The challenges in transitioning OYVTP students to academic architecture courses were determined, and a curriculum plan to facilitate this transition was outlined in this study. The education of lighting design revealed the evolution of the curriculum to integrate application tools. The results of the student survey indicated overall satisfaction with the learning and training method, with positive responses regarding the clarity of application operation, feedback during reviews, and the enhancement of design knowledge. In vocational training, industry needs, leveraging modern tools, and a smooth transition must be ensured for students in academic courses. The integration of lighting design into the curriculum exemplifies the commitment to providing relevant and practical skills. The findings from student surveys showed the success of the program in achieving its objectives, signaling a positive trajectory for the OYVTP in preparing students for interior design.

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