การศึกษาสภาพปัญหาและแนวทางการปรับปรุงวิธีการเรียนการสอน กลุ่มวิชาเทคโนโลยีโครงสร้างและงานระบบอาคาร

A Study of the Problems and the Improvement Direction of Teaching and Learning Methods in the Field of Building Construction Technology and Building System

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งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาสภาพปัญหาการเรียนการสอนในกลุ่มวิชาเทคโนโลยีอาคารเพื่อออกแบบ**แนวทางการปรับปรุงวิธีการเรียนการสอน**เพื่อให้เกิดผลสัมฤทธิ์ทางการเรียนรู้ที่เพิ่มขึ้น ผู้วิจัยมีความต้องการจะศึกษาสภาพการขาดองค์ความรู้และทักษะของนักศึกษาในการเรียนกลุ่มวิชาเทคโนโลยีการก่อสร้างอาคาร และค้นหาแนวทางการเรียนการสอนใหม่ที่มีประสิทธิภาพที่มุ่งเน้นการสร้างความเข้าใจและสร้างองค์ความรู้ให้นักศึกษา ซึ่งจะนำไปสู่การพัฒนาความรู้ความเข้าใจและสร้างความคิดสร้างสรรค์ในงานออกแบบสถาปัตยกรรมหลักและผลิตผลงานออกแบบที่มีคุณภาพได้ในอนาคต ผู้วิจัยได้กำหนดกลุ่มเป้าหมายผู้ให้ข้อมูลจากกลุ่มนักศึกษาภาควิชาสถาปัตยกรรมที่กำลังศึกษาวิชา**เทคโนโลยีการก่อสร้างอาคาร**ระดับแรกจนถึงระดับสูงสุดและคณาจารย์ผู้สอนกลุ่มวิชาเทคโนโลยีการก่อสร้างอาคารจากคณะสถาปัตยกรรมศาสตร์ของ 3 สถาบัน จำนวนทั้งหมด 30 คน โดยใช้การวิจัยเชิงคุณภาพผ่านการสัมภาษณ์และการสังเกตการณ์ในห้องเรียน และใช้**การวิเคราะห์โดยการจำแนกชนิดข้อมูลและแบบสรุปอุปนัย**จาก 1) เนื้อหาหลักสูตรในหมวดวิชาเทคโนโลยีการก่อสร้างอาคารและวิชางานระบบอาคาร 2) วิธีการสอน 3) วิธีการประเมิน**ผลสัมฤทธิ์ทางการเรียนรู้** 4) สถานที่เรียนและอุปกรณ์การสอน ผลวิจัยพบว่าเนื้อหาหลักสูตรและวิธีการสอนมีความคล้ายคลึงกันในแต่ละสถาบันโดยเน้นไปที่การสอนแบบบรรยายและการปฏิบัติการในรูปแบบสตูดิโอ แต่พบว่านักศึกษายังคงขาดความเข้าใจในกระบวนการก่อสร้างจริง อีกทั้งมีจำนวนอาจารย์ไม่เพียงพอกับจำนวนนักศึกษา วิธีการประเมิน**ผลสัมฤทธิ์ทางการเรียนรู้**ใช้การประเมินจากคะแนนสอบและงานที่ให้นักศึกษาทำส่งในสตูดิโอ ซึ่งวัดผลความรู้ความเข้าใจจริงได้ยาก ผลวิจัยพบว่ามีนักศึกษาบางกลุ่มเรียนรู้ได้ไม่ดีเท่าที่ควรเพราะองค์ความรู้ในเนื้อหาหลักสูตรของวิชาเทคโนโลยีการก่อสร้างอาคารมีมากและยากที่จะทำความเข้าใจ ดังนั้นวิธีการสอนต้องมีการปรับให้เหมาะสมกับลักษณะของผู้เรียนมากขึ้นและต้องสร้างทักษะที่ผู้เรียนควรจะมีเพื่อให้เท่าทันกับแนวโน้มความเปลี่ยนแปลงขององค์ความรู้เทคโนโลยีการก่อสร้างอาคารที่จำเป็น เพื่อการสร้างสรรค์งานสถาปัตยกรรมในอนาคต **การเรียนรู้แบบกระตือรือร้น** (Active Learning) ควรนำมาปรับใช้โดยให้ผู้เรียนได้เรียนรู้จากประสบการณ์งานก่อสร้างจริงและการออกแบบโดยใช้โปรแกรม 3 มิติควบคู่กับการเขียนแบบ 2 มิติ อีกทั้งควรสร้างความต่อเนื่องในการใช้ความรู้วิชาเทคโนโลยีการก่อสร้างอาคารในงานออกแบบของวิชาออกแบบสถาปัตยกรรม

คำสำคัญ: แนวทางการปรับปรุงวิธีการเรียนการสอน เทคโนโลยีการก่อสร้างอาคาร การวิเคราะห์โดยการจำแนกชนิดข้อมูลและแบบสรุปอุปนัย ผลสัมฤทธิ์ทางการเรียนรู้และการเรียนรู้แบบกระตือรือร้น

Abstract

This research aims to study the problem of teaching and learning in the building technology courses and design to improve teaching method and increase learning efficiency. The researcher intended to study the condition of student's lack of knowledge and skills in the building construction technology and searched for a

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new effective teaching to develop student understanding and knowledge for their creativity and quality in architectural design in the future. Researchers selected informants from two groups, 1) students in the Department of Architecture studying the building construction technology courses from the first level to the highest level and 2) lecturers teaching this subject from three schools of architecture. Qualitative research method was employed through interviews and on-site class observations. Data analyze was conducted through the typological analysis and analytic induction on 1) course content in Building Construction Technology and Building System courses; 2) teaching method; 3) evaluation method of learning outcome; and (4) teaching facilities and equipment. The research result revealed that the contents of the course and the teaching methods were similar in each institution, which were focusing on the teaching format of lecturing and practicing in a studio. However, the students still did not understand the real construction process. There were also not enough instructors compare to the number of students. The evaluation method of learning outcome was based on examinations and studio assignments scores, which were difficult to evaluate the students' true knowledge and understanding. The research also found that some students did not perform well because there were many course contents in building construction technology and too difficult for students to understand. So, the teaching method must be adapted in relation to characteristics of the learners and create the necessary skills for the learners in response to evolving of knowledge in building construction technology. Active learning method should be applied to give the students opportunities to learn from the real construction experiences and to design with computer-aided design programs along with the 2-dimensional construction drawings. The continued practice in building construction technology knowledge application should also be applied in the architectural design studios.

Keywords: Improvement Direction of Teaching Method, Building Construction Technology, Typological Analysis, Analytic Induction, Learning Outcome and Active Learning

1. Introduction

This research study started with the problem of the students' insufficient knowledge of the building construction technology and building system courses in Architecture Program, School of Architecture and Design, Assumption University. Regarding the Architect Council of Thailand's Program Assessment for the Architecture Program Curriculum 2009 of Montfort del Rosario School of Architecture and Design, Assumption University, a significant comment from the assessors was the issue of the students' insufficient knowledge on the building construction and building system and the knowledge application in the architectural design. This issue has brought an important point in the architectural study today in terms of teaching methods.

The researcher is interested in this issue and aimed to search for the cause of the students' insufficient knowledge on the subject to discover the improvement direction in order to implement the teaching and learning system for those courses in the near future. Nowadays, teaching methods for building construction technology and building system courses in the architecture schools are mainly focused on the lecture and studio learning formats. Mostly, the activities in the construction studios emphasize the individual working drawing training which usually conducted by following the format from the textbook or the given examples in the lectures. The next problem is the ratio between instructors and students are insufficient. The suggested appropriate ratio is 1 instructor to 8 students but the informant schools have the ratio between 1 instructor to 10 students and 1 instructor to 30 students. In consequence, the instructors have limited time to spend with each individual student in the classroom. This issue has led to the research hypothesis that the current teaching methods are no longer effective both in term of a number of instructors and students and the teaching format, which require an

implementation on the teaching method in order to achieve a better teaching and learning outcome. Another issue has been stated by Torrington that "architects are unresponsive to the needs of clients and users in building design and are not good at collaborating with other members of design and construction teams. It has been suggested that higher education is the source of these problems and that the interpersonal skills required for professional practice are not being sufficiently developed during the undergraduate years" (Nicol and Pilling, 2000, p.84).

A significant issue regarding the building construction technology and building system is that there is a lot of knowledge to be learned and they are difficult to learn in a short time. Many students have difficulty understanding all the technical terms that use in the building construction and system, which requires both understanding and practicing learning system. According to the teaching method which emphasized the lecture and studio format, the students will have difficulty understanding the real practice in building construction because they cannot visualize what is happening at the construction site and they will not understand the whole building structure system as well as the knowledge in building construction materials and building structural design. The result of this research will be used for implementing the current teaching content, lesson plan, class format, and the system to improve the teaching and learning strategy in all building construction technology and building system courses. The expected outcomes can be defined as followed:

1.1 Understanding the students behaviors and attitudes in the classes.

1.2 Define a clear direction for the courses teaching plan implementation.

1.3 Conduct a standard prototype for an effective teaching method for the building construction technology and building system classes.

1.4 Encourage students to change their study behaviors by providing an attractive teaching and learning format.

2. Research Objectives

This research aims to search for an effective teaching strategy to provide relevant knowledge, skills, and attitude for architectural students in building construction, structural design, building system, and other building technology knowledge, and apply them into the architectural design process. Therefore, the research objective can be categorized as followed:

2.1 To develop an understanding of the architecture students learning difficulties on the building construction technology teaching and learning process to understand the cause of the insufficient knowledge on the subject.

2.2 To study, analyze, and implement teaching strategy in the building technology courses in order to provide the appropriate knowledge and information and provide a better teaching improvement direction in the architectural study for a better learning outcome.

2.3 To use the result to implement an appropriate course content and teaching method for the Architecture Program Curriculum 2018' at Montfort del Rosario School of Architecture and Design, Assumption University.

3. Research Methodology

The research methodology will explore the important areas that pinpoint the learners' challenges in relations to Bloom's taxonomy learning model that contains Skill, Knowledge, and Attitude domains which can influence the success of students' learning outcomes. However, there are four areas to be studied in this

research: (1) course content or structure; (2) teaching and learning method; (3) students evaluation method; and (4) teaching and learning facilities. Three schools of architecture will be selected as the case studies. The Research Methodology Framework is designed in relation to the research objectives as shown in Figure 1.

3.1 Data Collections

The data will be collected from the necessary secondary data documents and the qualitative data collection from: (1) classroom observations; and (2) In-depth interviewing the informants (24 students and 6 lecturers from 3 institutes), and analyze the data based on the typological analysis and analytic induction principles. The data collection is listed as followed:

3.1.1 Secondary Data: this data source includes all the related documents, data statistics, and literature from the important sources such as the architecture program from the selected schools of architecture in Thailand. The significant data will include the students' background as well as their behaviors in classes and their interests on the subject, teaching materials, teaching content, teaching strategy as well as the teaching environment in the selected schools.

3.2.2 Primary Data: this includes the data from observation in the classes, in-depth interviews with teachers and students.

Figure 1 Research Methodology Framework Diagram

Source: Author (2018)

3.2 Informants

The informants have been selected from the architecture schools which contain various students' backgrounds and learning abilities to make a comparison with School of Architecture and Design, Assumption University. The selection criteria were set up from the nature of the students in terms of 1) variety of students who come from Bangkok, countryside areas; in Thailand, and other countries; and 2) the problem of the students' learning outcome. The selected schools are:

1) Montfort del Rosario School of Architecture and Design, Assumption University (AAU)

2) School of Architecture and Design, King Mongkut's University of Technology, Thonburi (SOAD, KMUTT)

3) Faculty of Architecture, Rangsit University (RSU)

There is a variety of student's background in terms of knowledge and design skills in the three schools. AAU and KMUTT have approximately seventy students in the classes but RSU has approximately 200 students in their building construction classes each year. The three schools have various range of students' levels from the excellent to poor level but the researcher has set the target group of thirty informants, and divided into the group of eight lecturers and the group of twenty-four students of Building Construction Technology's classes (the first level to the highest level courses) from the three selected architecture schools (two lecturers and eight students from each school). The students were divided into two groups between excellent and poor learning ability (four excellent students and four poor learning ability students from each school) to make a comparison by using a qualitative research method through interviewing.

3.3 Research Questions

The research questions began with the thinking of the overall content of the architectural study regarding the required knowledge and skills that the new graduate architecture students would need before beginning their professional practice in term of the building construction technology and building system. Generally, architecture schools have their own direction and the curriculums have been set to reflect their schools' direction. "Architecture was taught in the first as a structural science and in the second as an art of design associated with painting and sculpture" (Chakraborty, 2015, p.16). However, the curriculums would have to follow the requirements from the architect association or the architect council of each country to meet the standard for the students to obtain their professional license. The curriculums are usually set to the qualified standard requirements. Even though, most of the architecture schools were established base on either engineering or art backgrounds but the significant knowledge on the building construction is required. Therefore, the research significant questions to be answered are:

1) What should be the required knowledge and skills for the architecture students?

2) What are the students behavior and attitude? This question is intended to understand the students backgrounds (both Thai and non-Thai students) and their behavior in the classrooms. Hopefully, the outcome will provide an answer which will help encourage the students to pay more attention in the class and improve their attitude, and eventually improve their studies respectively.

3) What is the most effective teaching method to train architecture students the knowledge and skills in building construction technology and building system?

3.4 Conceptual Framework

According to Bloom's taxonomy learning model, "objectives were divided into three domains: cognitive, affective, and psychomotor" (Hoy, 2013, p.202). Cognitive (knowledge) refers to verbal Knowledge and declarative knowledge. The students should be able to organize how information and concepts are mentally arranged as well as allocating and regulating the cognitive resources. Skill-Based (psychomotor) refers to the routine development and procedure linkage and the ability to perform a task without conscious monitoring and with other tasks. Affective or attitude focuses on the attitude about learning, self-efficacy, perception about the ability to perform, goal setting, and motivation. (Bloom, Engelhart, Furst, Hill, and Krathwohl, 1956)

The author has applied three of Bloom's learning objectives into the research conceptual framework as demonstrated in Figure 2 on the student domain for skills, knowledge, and attitude.

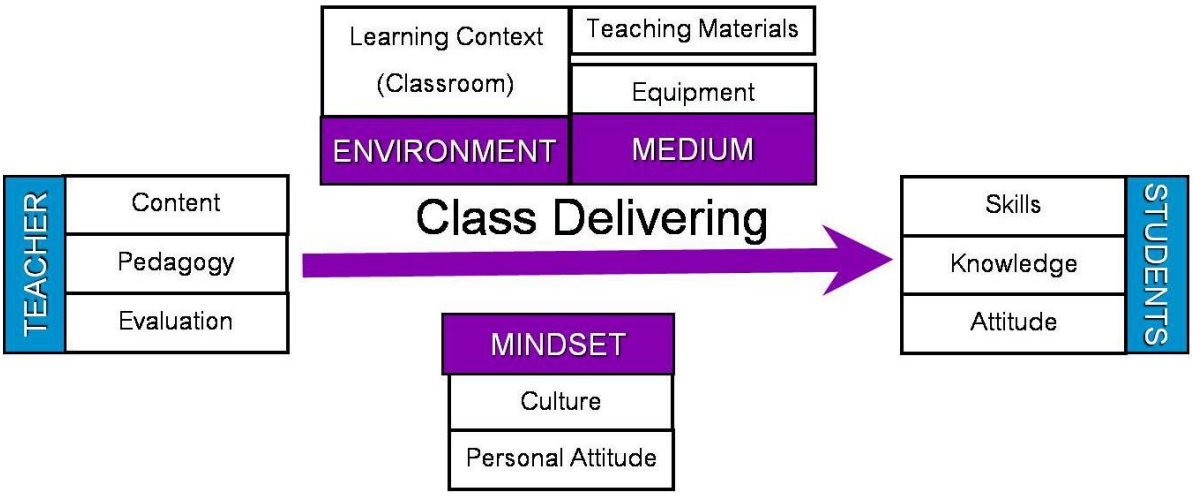

Figure 2 Research Conceptual Framework

Source: Author (2018)

3.5 Data Analysis and Discussion

All the primary and secondary data including the related literature, selected schools teaching content, current teaching method and format, in-depth interviews, questionnaires, and class observations, will be analyzed together to make a comparison between the selected schools. There are several significant issues to be analyzed as shown in Figure 3: the nature of the subject matters, teachers, students, facilities, courses synchronization, and limitation of resources. The result from this analysis will be used to define the teaching direction and teaching strategy respectively.

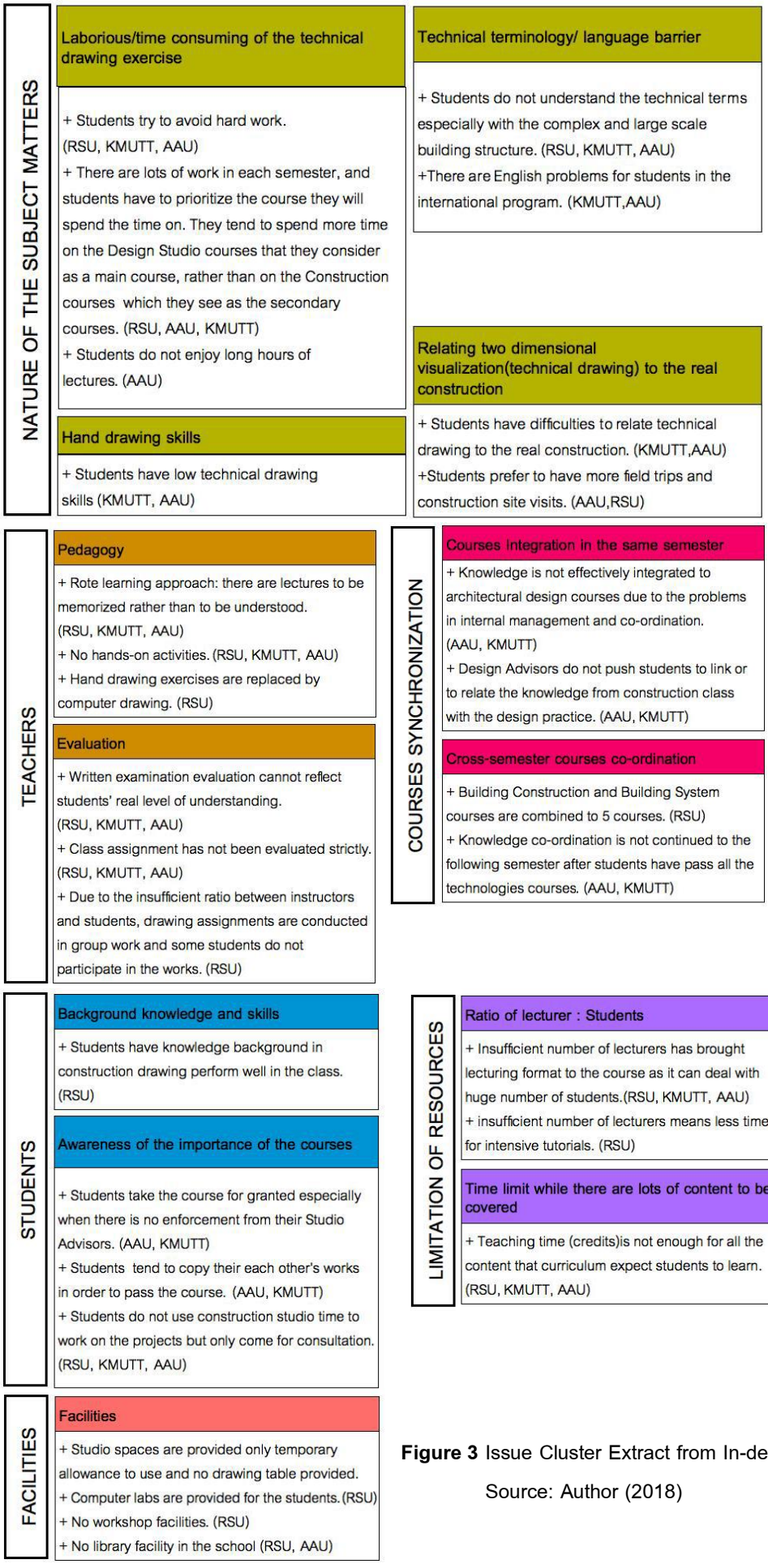

Figure 3 Issue Cluster Extract from In-depth Interviews

Source: Author (2018)

From the above diagram, it can be analyzed into three main aspects:

1) **There is a limitation in the resources** for both instructors and class time. Lots of information and knowledge are compressed into 5-6 classes, and each class contains 3-5 hours of study time each week. AAU has 4 courses for Building Technology and Construction of 3 credits (2-hour lecture, 2-hour studio), 2 courses for Building Environmental Control of 3 credits (3-hour lecture). SOAD, KMUTT has 3 courses for Building Construction Technology of 3 credits (1-hour lecture, 4-hour studio), 3 courses for Environmental Technology of 3 credits (3-hour lecture). RSU has combined Building Construction Technology and Building System into 5 courses of 3 credits (1-hour lecture, 4-hour studio). This is the reason why the teaching method must be taught in the lecture format.

2) **Facilities have not been fully used** by the students because the operation time of facilities is limited and the students prefer to work on their own computers. Students attend construction studio facilities only for consultation, and not working on their works because the existing facilities do not provide a good learning environment to motivate students to work at the school.

3) **The knowledge integration** from these supported courses to the architectural design courses is not effectively coordinated. The students' applications of the knowledge to the upper-level design classes and thesis are not strictly evaluated.

3.5.1 Knowledge Discussion: Evolving of Knowledge

The education training in building construction and building system studies need to be updated according to the evolution of materials and construction techniques as well as the environmental problems in which we face today. Spiller and Clear mention in their book that "We live in a time of eclectic paradox and extreme simultaneities, where very little seems to make sense in relation to economics, politics, social divides, global warming, carbon footprints and human interaction" (Spiller and Clear, 2014, p.11). "In recent years, architectural education has been presented with numerous creative opportunities to reconsider itself. These include the great tsunami of technology that has affected how we work, what we work on, what it is made of and when we work on it" (Spiller and Clear, 2014, p.11). This statement reflects the significant rationale to keep updating information in the building construction technology's teaching materials as well as to keep upgrading a suitable teaching strategy to suit the situation.

3.5.2 Skill Discussion: Active Learning with Hand-on Experience

The Book by Carpenter describes about craft in architecture education. Its central purpose is to inspire architects and students to see building construction as a creative act. "Construction sites reveal the way a building is made. The life of a structure is marked when the materials are stacked, when some order is assembled amid the chaos of activity at a site" (Carpenter, 1997, p.5). He also states an interesting question to the subject. "Why is the architect not more of a part in the construction process? In school, we are taught that the architect must observe construction. The architect works in another place, usually at a distance from the building activity, and sends a message through plans, drawings, and specifications to the site. Can the excitement of building and the construction site become part of the education process and, inevitably, the practice of an architect?" (Carpenter, 1997, p.5). The teaching format should not be concentrated only in the classrooms but the students should have opportunities to explore their experience with other design disciplines and communities through the actual practice on-site construction. Hands-on projects should be integrated more in this exercise to develop their understanding.

3.5.3 Attitude Discussion: Resilience and Multi-disciplinary Training

The building construction technology training format has long been organized in the studio classrooms which is also necessary but the important point is that we must collaborate the knowledge with other discipline and more important, to the architectural design studio classes. "The architect's role in today's practice has eroded as other professions absorb parts of our once comprehensive profession. Architects should have a knowledge of building and the respect once given to them by clients and other professionals. Never has there been a more opportune time to include construction studios in architectural education. With the recent focus on redesigning the way an architect learns, construction studios are an ideal vehicle to synthesize complex areas of knowledge. Technology can be linked with the design studio" (Carpenter, 1997, p.5).

Another criticism in the literature discussion is that the architecture schools are often sealed themselves off from other departments on campus and from the surrounding communities. "Construction studio can offer students the opportunity for cross-disciplinary approaches and projects that reach out to the community groups who are in need" (Carpenter, 1997, p.6). Students should have more opportunities to learn the ability to communicate with teammates and actual clients and learn that architecture is a collaborative effort and not an individual practice. "Through the project, the students became aware of the skills in each discipline in relation to design and of their interrelationship in design" (Nicol and Pilling, 2000, p.117). Social service projects can be the answer the alternative direction of training their knowledge as well as encouraging the ethic of giving back to society. "Architecture is a socio-cultural profession, and to make it possible to participate effectively in this milieu, architecture education must take on an enabling role, geared at educating people to engage in creative and critical problem solving for architectural and urban issues. In this role, students are taught to take on transformational learning skills, since architects are often required to produce new ideas and solve problems for which they have not explicitly been trained" (Hisarligil, Lokce, and Turan, 2013, p.63).

3.5.4 Teaching Method Discussion: New Direction for Pedagogy in Architectural Training

In the book “Spatial Design Education: New Directions for Pedagogy in Architecture and Beyond”, Salama described the architecture education as the cornerstone of design profession that is contributed to shaping the built environment of the future (Salama, 2015). The main discussion emphasized the theories, contents, methods, tools, that evolve design education with a focus on the training in studio classrooms as the backbone. An interesting theory of 'Trans-critical' pedagogy demonstrates how a student-centered, outcome-based education sheltered in a wide variety of learning settings can profoundly change the thrust and teaching of architecture.

Despite all the above review, one of the important issues brought up into a discussion in that the best way to train architecture students is always been the 'one to one' teaching method with students to achieve the best learning outcomes. "The best architecture schools employ iterative teaching methods conducted one to one with students; universities see this as uneconomic. The best architecture schools ensure that nothing is off limits to their students' growing understanding of their world; universities like transcribed learning outcomes, all legislated by politically correct jargon to ensure 'quality', allegedly" (Spiller and Clear, 2014, p.13). This has brought up a challenge to the researcher to search for the best solution to achieve the goal and to search for the teaching method that is affordable.

4. Research Result

4.1 Course Content: Knowledge

The structure of teaching plan and course outline are similar in each school because all the architecture schools have to follow the standard requirement from the architect council and the academic council. The structure of the teaching content and teaching material for building construction technology courses consisted of the knowledge of the construction materials, construction techniques, building sizes, and structural typology. The building construction materials mainly consist of timber, steel, and concrete. Building system courses contain the knowledge of: electrical system, water supply system, water drainage and treatment system, HVAC system, fire protection system, vertical conveyor system, security and communication system, and smart system. Other building technology courses contain the knowledge in sustainable design and energy preservation.

4.2 Teaching Method: Skill

All the three school informants had similar teaching and learning system which used lecture and studio format. The skill training system emphasized the construction drawing training in the studio which did not provide a clear understanding the on-site construction process for the students. There was also an inadequate ratio between instructors and students (1 instructor: 10-30 students), which created an ineffective one to one training in the studio due to the limited consultation time. Therefore, this teaching method is currently used because of the resource limitation (both instructors and time) but it has caused the students' lacking understanding on the knowledge.

4.3 Learner Evaluation Method

The current students' evaluation method is basically based on examination and assignment scores in each semester, however, they did not display the students' true understanding the knowledge. The continuity of knowledge evaluation after the students have passed the building construction technology courses were also not effective even though the schools intended to integrate all the knowledge in the architectural design classes but there are limitations in term of the number of instructors and evaluation time for each individual student. The students had various learning abilities background in term of knowledge, design skills, and the language skill in each informant group, especially the students in the international programs at AAU and SOAD, KMUTT. Non-Thai students have less ability on the drawing skills. Some students also did not fully understand the courses they were required to take before the semester commenced. So, they were unprepared and had lost their interests in the building technology courses respectively. Some students claimed that the knowledge in the building construction technology has not been fully used and re-evaluated after they have passed the courses.

4.4 Learning Facilities

Learning facilities, including lecture rooms, studio rooms, laboratories, workshops, and learning tools, have not been fully used in the teaching and learning methods because of the limited classes time each week. Students tend to use their own computers to conduct their assignments because the schools facilities have limited operation hour which is not convenient for the students to access outside the classes.

5. Conclusion and Recommendations

Course content for building construction and building system are followed the standard requirements from Architect Council of Thailand to meet the standard credits but there are lots of information and knowledge to be learned. The resources in term of instructors and teaching and learning time are limited, so the current

teaching methods are based on lecture and studio format. However, the learners' skill development require one to one training with on-site construction experience. Many students do not have an awareness that this knowledge and skills can uplift their architectural design works. So they try to avoid the subject and tend to memorize the knowledge rather than understanding it. The research has suggested that the instructors should provide the students with experience on-site construction works by providing more opportunities for construction site visits or field trips. The schools should also provide a re-evaluating mechanism in the architectural design studio courses and thesis in the fourth and fifth years by including structural design technology and building system in the studios' submission requirements. However, the differences in the students' knowledge and skills from those schools suggested that the teaching methods should be implemented according to the student groups, and the needs of each group. Hands on assignments should be more integrated in the class through academic services to the community. Another important mechanism to the students' various learning ability background is an effective intensive course to prepare the students before starting the first year's training. The intensive program can also integrate some basic structural and building system assignments in the class. It is important to motivate and cultivate students a willingness to learn the knowledge with the active learning through discussions, problems solving, brainstorming, and practice in the real situations. The active learning method should be applied from the real construction experiences and the design through 3-dimentional program along with the 2-dimensional construction drawings. The faculty members from all the schools also believed that the integration of building construction technology and building system knowledge in the major course (Architectural Design Studio) can generate a better understanding and reduce the workloads for the students.

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