A Framework for Technical Courses in Design-Oriented Architectural Education

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ABSTRACT

Technical courses, including structural courses, materials, construction, building physics, and building services, generally form an important part of architectural schools' curriculums, as these courses provide necessary knowledge for fulfilling design projects. Despite its significance, technical subjects are often overlooked by students of architecture. Generally, less time and effort are dedicated to these courses and they are perceived as a less important part of their architectural education and design projects. Part of this issue may be caused by a lack of proper teaching and learning methods to deliver these courses.

This study aims to develop a framework for teaching/learning technical courses responding to the 21st - century competencies essential for architecture students. For this purpose, the study, as an analytical study, depends on a vast literature surveyed from the scientific databases seeking appropriate learning theories and pedagogical methods to be applied in teaching/learning these courses. In analysing the literature in the initial stages, the student-centred strategy was thought as an appropriate choice to be researched in this way. Consequently, the next stages of the literature survey were mostly focused on the origin of student-centred strategy and theoretical foundations supporting it. Furthermore, research was conducted on architectural education, how knowledge is transferred in the design studio, the role of technical courses in the architects' life, and the relation of technical courses and design.

The study results showed that the learning theories and pedagogical methods applied in transferring knowledge in design could be suitable for forming the framework for teaching/learning technical courses. The proposed framework then integrated into Necdet Teymur's 4X4 matrix proposed to assess architectural education program, curriculum, course, or project design to see if the new framework can be applied for teaching/learning technical courses.

Keywords: Architectural education, technical/construction courses, learning methods, student-centred learning, teaching/learning in design.

ÖZ

Strüktür, malzeme, yapı, yapı fiziği ve bina servisleri dahil olmak üzere teknik dersler, genellikle mimarlık okullarının müfredatlarının önemli bir bölümünü oluşturur, çünkü bu dersler tasarım projelerini gerçekleştirmek için gerekli bilgileri sağlar. Önemine rağmen, teknik konular genellikle mimarlık öğrencileri tarafından daha az önemsenir. Genel olarak, bu derslere daha az zaman ve çaba harcanır ve mimarlık eğitimlerinin ve tasarım projelerinin daha az önemli bir parçası olarak algılanır. Bu sorunun bir kısmı, bu dersleri vermek için uygun öğretme ve öğrenme yöntemlerinin bulunmamasından kaynaklanıyor olabilir.

Bu çalışma, mimarlık öğrencileri için gerekli olan 21. yüzyıl yeterliklerine yanıt veren teknik dersleri öğretmek / öğrenmek için bir çerçeve geliştirmeyi amaçlamaktadır. Bu amaçla, analitik bir çalışma olan bu çalışma, bu derslerin öğretiminde / öğreniminde uygulanacak uygun öğrenme teorileri ve pedagojik yöntemler aramak üzere, bilimsel veri tabanlarından yararlanan geniş bir literatüre taramasına dayanmaktadır. İlk aşamalarda literatür incelenirken öğrenci merkezli stratejinin bu şekilde araştırılması uygun bir seçim olduğu düşünülmüştür. Sonuç olarak, literatür araştırmasının sonraki aşamaları çoğunlukla öğrenci merkezli stratejinin kökenine ve onu destekleyen teorik temellere odaklanmıştır. Ayrıca, mimarlık eğitimi, bilginin tasarım stüdyosunda nasıl aktarıldığı, teknik derslerin mimarların yaşamındaki rolü ve teknik dersler ile tasarımın ilişkisi üzerine araştırmalar yapılmıştır.

Çalışma sonuçları, tasarımda bilgi aktarımında uygulanan öğrenme kuramlarının ve pedagojik yöntemlerin teknik derslerin öğretilmesi / öğrenilmesi için bir çerçeve oluşturmaya uygun olabileceğini göstermiştir. Önerilen çerçeve daha sonra, yeni çerçevenin teknik dersleri öğretmek / öğrenmek için uygulanıp uygulanamayacağını görmek için mimarlık eğitimi programını, müfredatını, dersini veya proje tasarımını değerlendirmek için önerilen Necdet Teymur'un 4X4 matrisine entegre edildi.

Anahtar Kelimeler: Mimarlık eğitimi, teknik / yapı dersleri, öğrenme yöntemleri, öğrenci merkezli öğrenme, tasarımda öğretme / öğrenme.

DEDICATION

If this dissertation is a success, I dedicate it to my father's soul whom I lost him during the journey, and to my loveliest family (Hozan, Saryan, and Nwa). You have made this difficult journey an enjoyable one.

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INTRODUCTION

1.1 Introduction

Technical courses in architecture are science and technology-based courses, consisting of several courses, including structural courses, materials and construction courses, building physics, and building services courses. These courses in architecture are expected to serve the technical side of design. However, many researches have shown that technical courses have become a lesser important part of architectural education (Carpenter, 2004; Nicol & Pilling, 2005; Ridgway, 2003; Voyatzaki, 2002b; Yunus, 2000). This shows contradiction with the significant role that construction and technology have in architecture because, without this knowledge, design concepts remain incomplete. Students cannot hide that they are not motivated enough to take these technical courses (Yunus, 2000). What has made these courses are seen can be a result of teaching/learning methods used in these courses. The current teaching/learning methods often used in technical courses seem to neither keep up with the recent teaching/learning trends nor with the teaching methods applied in transferring knowledge in architectural design. In design education, a unique education method based on studio work is utilised, where it is tried to enable students to learn through a process dealing with design problems.

Uzunoglu and Quriesh (2012) explain design in architecture as a problem-solving process, which embraces ‘function,’ ‘from,’ and ‘construction.’ However, for

Hambeukers (2020), design is more than just a problem-solving. However, it is "operational (beauty), tactical (problem-solving) and strategic (question finding)". So, design as a problem-solving activity that solves design problems is one part of the main argument because students involved in a continuous process of solving and finding problems when they undergo learning design. In this process, they learn how to reflect and analyse what they get from design studio instructors' critiques and decide what to do regarding finding a suitable solution for a specific problem.

Design is considered the backbone of architectural education (Salama, 2007). Knowledge from other courses, including technical courses, is expected to serve design and integrate it via a suitable pedagogical method. However, problems in teaching/learning technical courses have a global dimension nowadays (Ridgway, 2003). Generally, technical subjects' education is carried on to make it hard for the students to integrate what they learn in these courses apply it in the design, as these courses are taught in conventional methods. This age of rapid changes in technology made a huge challenge for architecture students to keep up with the developments related to the technicality of the man-made structures. This circumstance influenced the education of these courses how and what to be taught and learned. The students of architecture should not only gain the necessary knowledge related to technical issues in design but also develop abilities to adapt their knowledge to any new situation they might face with. Generally, this is what is aimed at the design education within the design studio model. By designing several building typologies in the design studios in different semesters, students are preparing to design endless building/project types in different contexts and situations. Developing this quality in thinking makes these individuals adapt to the rapid developments in technology and acquire the 21st -

century competencies. What the 21st -century competencies are mainly emphasized is interpersonal, intrapersonal, and cognitive skills development. Hence, communication, teamwork, responsibility, and dispute mediation are both interpersonal skills. Flexibility, initiative, diversity awareness, and the capacity to draw on one's own learning are examples of intrapersonal skills. Lastly, critical thought, knowledge literacy, logic and argumentation, and imagination are also cognitive skills (Russell, 2016).

A comparison has also been made to the study and the similar work from the literature to be discussed. (a) “Study on Learning and Teaching Construction Technology Related to Design -A Case for Architectural Schools in Malaysia” by Yunus (2000), (b) “Radical Constructivist Structural Design Education for Large Cohorts of Chinese Learners” by Herr (2014), and (c) “Integration of building construction courses in the architecture education programme” by Alakavuk (2016).

The first study (a) targeted construction technology course in architectural education in Malaysia. It depended on an action method through asking questions to both instructors and students regarding their preferred teaching method to be applied for this specific course and interrelating the results to the learning methods. The study affirmed that the results from the teachers slanted towards cognitivism as an appropriate choice to be thought in rearranging the teaching/learning process. At the same time, most of the students accepted ‘rote’ teaching. The second (b) study has been conducted on applying radical constructivism to teaching structural design in large cohorts of Chinese students in architecture. The study looked for a solution to the huge number of students, almost ‘200’ students in a class. The researcher applied some perspectives from constructivism to encourage individual learning and showed the challenges and opportunities. The third (c) study, which is about integrating construction courses into design studio, has been done using a software (ideCAD) to analyse and examine the existing structural systems and benefitting this knowledge in their design projects. Students directed to learn about the dimensions of the structural members, from the beginning of their design projects, that may resist the earthquake loads via the simulations.

This study attempts to develop instructional strategies in technical courses based on suitable teaching/learning theories and pedagogical methods.

1.2 Statement of the Problem

Technical courses should help students to keep up with the design and the rapid developments of technology. Construction subjects and technical knowledge are important for design in architecture, and they should have a deserved value in the curriculum of architectural schools. Overlooking technical courses cause undesirable consequences in educating prospective architects. However, the controversy around the separation of architectural design and technical courses has a strong premise. Part of it is caused by not having a suitable teaching/learning method to learn technical knowledge better and integrate it into the design. Students seem more engaged in design and less about the other technical subjects (Dobson, 2015).

Problems faced in teaching/learning technical courses are addressed in the literature frequently. Carpenter (2004), Ridgway (2003), Watson (1997), and Yunus (2000) mention the problem related to the disintegration of technical knowledge with the design, and Dobson (2015) argues the issue of theorizing technical knowledge in some schools of architecture. Similarly, MacDonald and Mills (2013), Voyatzaki (2002b), and (Yunus, 2000) highlight inappropriate teaching methods used to teach these technical courses in architecture. Another problem is the unrelated content of these courses taught in architectural schools to what is needed in the market (Nicol & Pilling, 2005; Ridgway, 2005; Spiridonidis & Voyatzaki, 2009; Voyatzaki, 2002b; Watson, 1997). Nevertheless, none of them so far attempted to find a teaching/learning method for all these technical courses. For this reason, this study intends to prepare a student-centred framework for teaching/learning technical courses parallel to what is called 21st -century competencies, which comprises critical thinking, problem-solving, decision-making, adaptive learning, collaboration, initiative and self-direction, etc. (Finegold & Notabartolo, 2010).

1.3 Purpose Statement

There exist several studies on deficiencies of methods of teaching technical courses in architectural education. However, most of these studies do not suggest a new method aiming to bridge this gap. Moreover, due to the rapid changes in technology and proliferating knowledge, it seems that it is no more possible for technical courses to cover all construction systems, materials, and techniques. Thus, a method of education that allows students to adjust themselves to various situations is vital.

This study intends to propose a framework for teaching/learning technical courses, hoping to synchronise design and technical courses in architectural education and enhance engagement and deeper learning by the students and let them adapt themselves to the field's continuous developments. The goal is to make students develop a more self-directed learning approach necessary for the 21st -century competencies.

1.4 Objective

This study proposes an appropriate framework for teaching/learning technical courses in architectural education by considering suitable pedagogical methods for a self-directed student-centred approach and adapting learners to the 21^{st} -century competencies.

To better understand the goal of the research, the study raises this main research question:

- What framework can help instructors teach the students to acquire the necessary technical knowledge in accordance with the 21^{st} - century competencies?

While to approach the response of the main research question, it is necessary to have several other questions to be answered, which are:

- What are the currently available teaching methods that are applied in delivering technical courses?
- What are the properties/ necessities of student-centred education, and what strategies can be used?

1.5 Methodology

A qualitative research method has been applied in this study, which depends on theoretical data and documentation of studies from the literature. The study, first, delves into the architect's role in different periods, from the beginning of the history of architecture, which dates back to Vitruvius's writings on architecture in the 1st century until nowadays and highlights the changes that occurred. The study investigates the change in the architect's role through history, architectural education, technical courses, their position in architects' education and practice, then to 21^{st} -

century competencies and learning theories. Due to emphasizing these changes, a chronological event is shown and then discussed depending on the literature.

This research considers theories related to learning and instructional/learning strategies. Choosing data from the related theories and interrelating them is to find the possible tailored answer to the research questions. By analysing the literature, several tables have been prepared to emphasize themes that can prepare a base for the framework suggested for these technical courses by analysing the literature. This technique helps to compress a vast literature discussion into fewer themes and keywords.

The study also researched the position of technical courses in the top-ten architectural schools for 2018 and the architectural education accreditation boards; analyses were done, and comparison tables were prepared. Moreover, 21^{st} -century competencies have been discussed and surveyed. Then, the currently existed methods and tools for teaching/learning technical courses were also highlighted. Then, texts are scanned to derive necessary keywords and find the exact phrases that best describe the phenomenon under study (Seers, 2012). After the framework been proposed, Necdet Teymur's 4X4 matrix for assessing architectural education curriculum has been used to assess the viability of the framework to be applied for teaching/learning technical courses.

In this study, massive text data has been analysed. Data were taken from books, journal articles, manuals, guidelines, electronic sources between February 2016 and December 2019. Data sources about the architect's role throughout the time, architectural education, 21^{st} -century competencies, technical courses and currently teaching/learning methods, and teaching/learning theories are surveyed.

This study's selected literature is multidisciplinary and covers a wide range of subjects; it has been purposely chosen as such—these included topics related to architectural design, educational theories, and pedagogies. In addition, the 21^{st} century required skills are focused on being the base of the framework, which is a hot topic in research today. The study found a structured literature survey as the best choice through preparing tables for the themes and keywords obtained from the literature survey.

Atlas.ti, as a qualitative data analysis software, and Scholarcy, have been used to facilitate the process. After an article was chosen by its title and abstract, for instance, it passed through the Scholarcy to highlight and summarise the important content; then it was input into Atlas.ti to know how much it was related to the subject by deriving the highlights and information has been taken.

The search terms applied in the databases for this research included: *architectural education, technical courses, the role of the architect, profession of architecture, the discipline of architecture, design, good design, architectural design, history of architecture, built environment (physical, social, and symbolic), top architectural schools, pedagogical methods in teaching technical courses, learning theories, instructional/learning strategies, student-centred approach, problem-based learning, game theory,* 21^{st}*-century skills,* and other related terms.

The data taken from the sources were carefully analysed using a structured literature survey by highlighting the subjects' themes. In this process, Scholarcy summarises the documents and highlighting and Atlas.ti was used to arrange themes, put codes on them, and write memos on the themes. Although, in essence, researchers must read word by word from documents. Themes, codes, and memos in Atlas.ti can be filtered according to the purpose and can be linked together and produce network views of data. After the researcher decided on the final form of themes and codes, a co-occurrence table was produced by Atlas.ti, which contained the main themes and references of the applied literature shown at the end of the chapters. Through an analysis, which was mainly presented in chapter two, all the themes and keywords were first compared. An understanding was then formed of the link between design and the related learning theories. This was throughout gleaning the data and delving into the nature of teaching/learning design in architecture and student-centred learning strategies, which prepares students to be more self-directed and sustained in this rapid era of technological development and considering it in teaching/learning technical courses.

After that, a framework was prepared based on a student-centred approach and emphasizing the 21st -century competencies. The framework presented comprises the pedagogies, techniques, and strategies to apply for teaching/learning technical courses nowadays.

1.6 Significance of the Study

The subject of reintegrating technical knowledge in architectural design has been studied and researched by several researchers. This issue has great importance to be scrutinized well. This study would contribute to ascertaining a suitable teaching/learning method for technical courses that may match the 21st-century competencies. This study's outcome would be beneficial to students of architecture, as they will learn technical knowledge more autonomously in the same way they learn design. As a result, the lack of synchronisation between design and technical courses produced insufficient architects' skills, which can be compromised. This can also help instructors to formulate their teaching strategies less cloudy.

The framework produced can be adapted for different situations, be applied as it is, or be inspired-by accordingly. This study also may serve as a reference document to those who may wish to conduct similar researches on the subject.

1.7 Scope and Limitation of the Study

This study tries to propose a framework for teaching technical courses in architectural education. For that reason, it evaluates architectural education. It emphasizes the understanding of the design and technical courses, their relationships, causes and effects of separation in architectural education, and the influence of this separation on architect, education, and the profession. The study focuses on the current instructions for teaching these technical courses and teaching/learning methods. However, this study does not evaluate all existing teaching/learning methods.

Nonetheless, the study attempts to be selective to the methods associated with teaching design and supporting student-centred. Other methods are described out of this frame is to make a comparison to these methods for further understanding of the subjects. Design is more than problem-solving. Indeed, it is one side of the argument. Yet, introducing design as a problem-solving is a predominant characteristic of architectural design. That is why the study mostly emphasizes design as a problem-solving. The framework remains inclusive; the content of the technical courses has not been targeted. Similarly, the assessment has not been focused, and scenarios that are proposed are organized as such.

Learning technical knowledge from the natural and the built environment and game theory are also taken, which are associated with the previously mentioned subjects. Furthermore, studies conducted on teaching and learning technical courses are rare, and it was one of the author's challenges during the study. The outcome of this research expects to be a framework for teaching/learning technical courses to be suggested for architectural education as a general.

1.8 Structure of the Dissertation

- Chapter 2 provides a literature review about the changing role of the architect in the history, design, architectural design, architectural education, and culture of the design studio, technical courses, and methods of delivering them in schools of architecture, and it also sheds light on the profession of architecture and its challenges. This chapter forms an understanding of the necessity of knowledge integration between design and technical courses.
- Chapter 3 explains teaching-learning methods, behaviourist, cognitivism, constructivism, and social learning theory. Then, it describes problem-based learning (PBL) as a pedagogical method of constructivism, which has congruence with the nature of architectural education and design and student-centred learning approach. Game theory, game-based learning, and gamification are clarified as one of the student-centred learning instructional strategies. Besides that, links between these theories, instructional/learning theories, and 21st -century skills are also discussed.
- Chapter 4 converges the previous chapters' ideas to propose teaching/learning technical courses based on the link between design, constructivism (problem-based learning to student-centred learning instructional strategies), and interconnections with 21st-century skills. The study then exhibits two potential scenarios from the proposed framework applied in teaching/learning technical courses.
- Chapter 5 provides the conclusion and implications for further research on this subject.

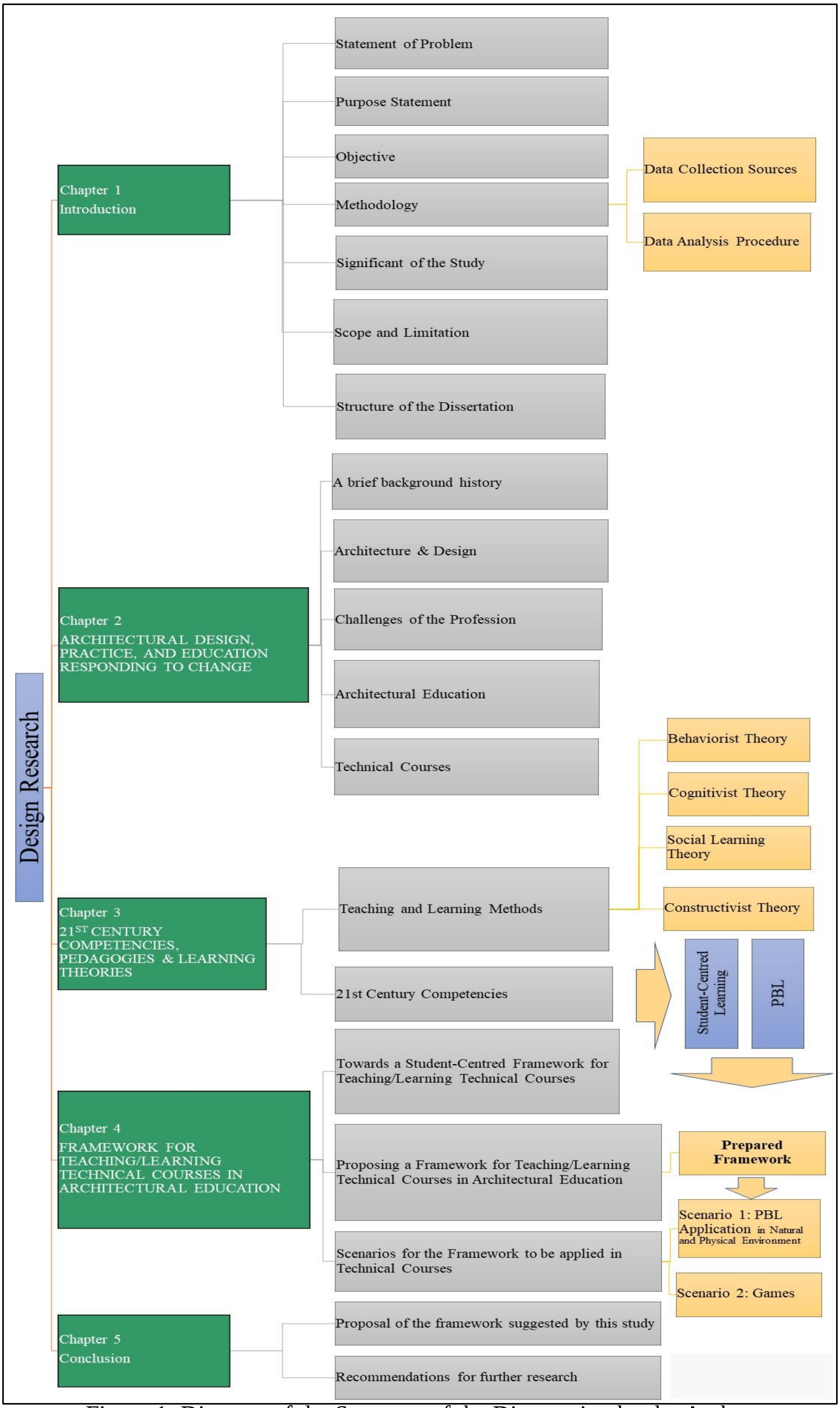

Figure 1: Diagram of the Structure of the Dissertation by the Author

Chapter 2

ARCHITECT'S ROLE, ARCHITECTURAL DESIGN, PRACTICE, AND EDUCATION RESPONDING TO CHANGE

2.1 Introduction

This chapter forms a discussion about relevant spectrums as the role of the architect, architectural design, practice, architectural education, and technical courses. Generally, this divergent research to the mentioned subjects is to understand architecture's culture and its specific nature. The subjects surveyed highlight significant changes that architecture, both as a profession and discipline, has been undergone. Thus, it underscores when specific characteristics of architecture were dominated. Then the study deals with technical courses in more details regarding their position in architectural schools, in architectural accreditation boards, and the tools and methods which are applied in teaching and learning them. For that purpose, the study focuses on the curriculum of the top ten schools of architecture ranked by QS university ranking in 2018, and taking the requirements of NAAB, AACA, and RIBA into consideration.

2.2 A Brief History about Changing the Role of Architect throughout the Time

Understanding the architect's role in the present demands a looking back to the past because it is the past culture that helped architecture and construction take shape as seen today (Miller & Burr, 2002). The more underscoring architects' past roles in design and construction, the better the realization of today's and future architects' responsibilities can be set. Jackson (1995) likely mentions that through unravelling the past, we can realize the present.

Architects, in time, have undergone many different roles as shown in Figure 2 & Figure 3. They were named accordingly, because of the various situations and demands of every period. That is why the architect's responsibility or position witnessed many changes throughout history (Taylor, 2000). In essence, architecture comprises several components as science, engineering, social and artistic approaches. While the graduates of architecture are more limited than artists. They have to deal with customers and financial issues, as well as the need for their inventions to run correctly and adhere to a stringent set of rules and regulations (Goldberger, 2015).

The significance of some building functions, such as in Egyptian culture, elevated architects' position to a high level because the wealthy class was the main consumer of what architects were doing in Egypt, Mesopotamia, and Greece. Architects in ancient Egypt had access to all important official documents and were respected; they were always required to design, renew or extend institutional, law court, residential units, or other types of buildings (Kostof, 2000). Unlike Greeks, Egyptian architects were great modellers and had high drawing skills (Hahn, 2001). They drew plans and construction details on papyrus papers or leather and kept them in archives. In ancient Egypt, the architect had a clear-cut definition separated from engineering and city planning (Kostof, 1977).

The word ‘architect’ had come from ancient Greece; the word ‘Arkhi’ referred to master or head and the ‘Teckton’ to builder or worker (Berman, 2003). Herodotus first used this term in the 5th century B.C., which was applied for: ‘architects’ of today's’ sense, those who undertook the underground canals of water to Samos, and to the engineers who were working in making bridges (Kostof, 1977).

Greeks paid extra attention to architecture as they revolutionized their society from being a nomadic statue to a permanent basis. They also started building temples to resemble their religious beliefs (Miller & Burr, 2002). In building any temples or other building types in ancient Greek, the architect was responsible for setting all details to the form of the building and construction issues on site. The details were transferred to a stone/wood-mason by the architect, especially through verbal descriptions (using words and numbers), before the fifth century, called syngraphai rather than on the drawings (Hahn, 2001). That made the architects more curious about imagining and reinventing the building details. These technical and constructional skills needed many years to be learned by a would-be master builder/architect.

Being a master builder reassures the notion that this character was responsible for both design and construction. Furthermore, it had a role in the pinnacle of this process at different times. However, this role was dissimilar regarding the building materials of the project. For instance, a master builder would be a head-carpenter in case if the building material was wood, or a head builder if it was stone (M. N. Woods, 1999). Going back to the ancient Greeks period, the visible Greek landmarks that can be seen today as stone artefacts, many of them were constructed from wood previously. For this reason, the first architect or ‘Arkhtekton’ was a master carpenter (M. N. Woods, 1999).

What is known on ancient Greek architects' education is limited; there is not much to go by it. However, the occupation as an architect was considered as an upper-class occupation. Architects received inspiration mostly from their families if they had a background of that or the other masters. What is available as a record shows that a would-be architect had to start learning building crafts, or any different sorts of art such as; carpentry skills, metal works, etc., and should practice and receive experience before becoming an architect (Kostof, 2000). There are some records from the Greek treatises dating back to the 4^{th} century B.C. and before; the architect is not the primer figure in these public records, yet, there is some valuable information on architectural theory and technical subjects on construction. These were a great advantage for architectural education later on (Barrow, 2000).

Roman Empire is well-known for its vast possessions of planned cities and official and private buildings. Architecture had both functional and symbolic significance for the Romans. Architects had a lot to do and were expected to have diverse knowledge in the empire. A thoroughly trained and qualified architect had to have enough knowledge and skills in planning, surveying, hydraulic engineering, and know-how knowledge in construction (Barrow, 2000).

During the Middle Ages, again, the role of architects underwent a turbulent wave of change. The architect was expected to plan functionally and aesthetically accepted artefacts, relegated to a figure who only dealt with the technical side of buildings; more specifically, the architect was merely seen as a mason or a builder (Pevsner, 1942). Being in a builder's role, the market demanded more technical knowledge and less intellectual awareness of other design aspects.

Later, and in the Renaissance period, the architect’s role recorded another milestone, mostly altered to more intellectual rather than technical. This change was parallel with Alberti’s treatises on architecture in the fifteenth century; Alberti believed that architecture had little to do with building construction (Bevilacqua & Williams, 2014). Since then, the separation of design and construction has appeared. The architect became an artist-architect rather than a craftsman or a master-builder. Since many ‘creative-genius-design’ architects appeared in that time, the demand for someone skilful in the technical field rose, especially in the late Renaissance period.

The controversy around the separation of intellectual and technical skills was apparent later. For instance, Michelangelo declared that besides his designs, he did not consider himself as an architect as he did not have construction knowledge (Kostoff, 1977).

After that, architecture gave birth to two disciplines; military and civil engineering, in 1747 in Paris. It was a massive change in the profession of architecture, while real professional solidarity happened in 1834 through the Institute of British Architects' foundation. Then, the designation of ‘Royal’ added to the institute in 1866 by Queen Victoria. The main aim of the Royal Institute of British Architects (RIBA) was to “prevent ‘the great contaminating trade element’ such as builders, carpenters, cabinetmakers, ironmongers, painters and undertakers from undermining the professional status of architects” (Conway & Roenisch, 2005, p. 14).

Industrialization boomed another big change in architecture, like engineering, due to the time demand, had separated from it. Even more closely, the design-specialist internally divided into many other sub-branches as ‘interior, environmental, ecology, fire, acoustics, etcetera,’ this has produced a further complex technical knowledge requirement. Furthermore, building manufacturing due to its various components has made the profession of architecture more fragmented, which probably nobody can acquire all the essential skills needs in the market regarding the building industry alone (MacDonald & Mills, 2013). Installing the first electric elevator in 1889 in the U.S. highlighted that apprentice-trained craftsmen no longer could keep up with what is going on in the construction industry, but rather the specialists should do that (Thomsen, 2002).

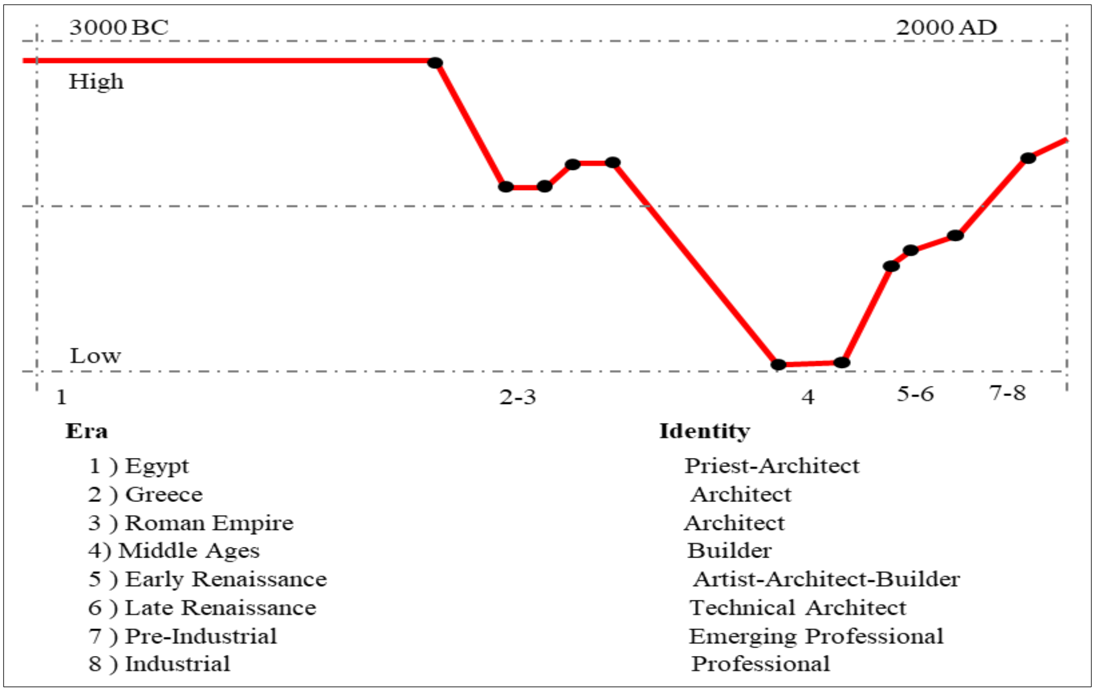

Figure 2: Social Statue of Architect Throughout Time According to Barrow (2000)

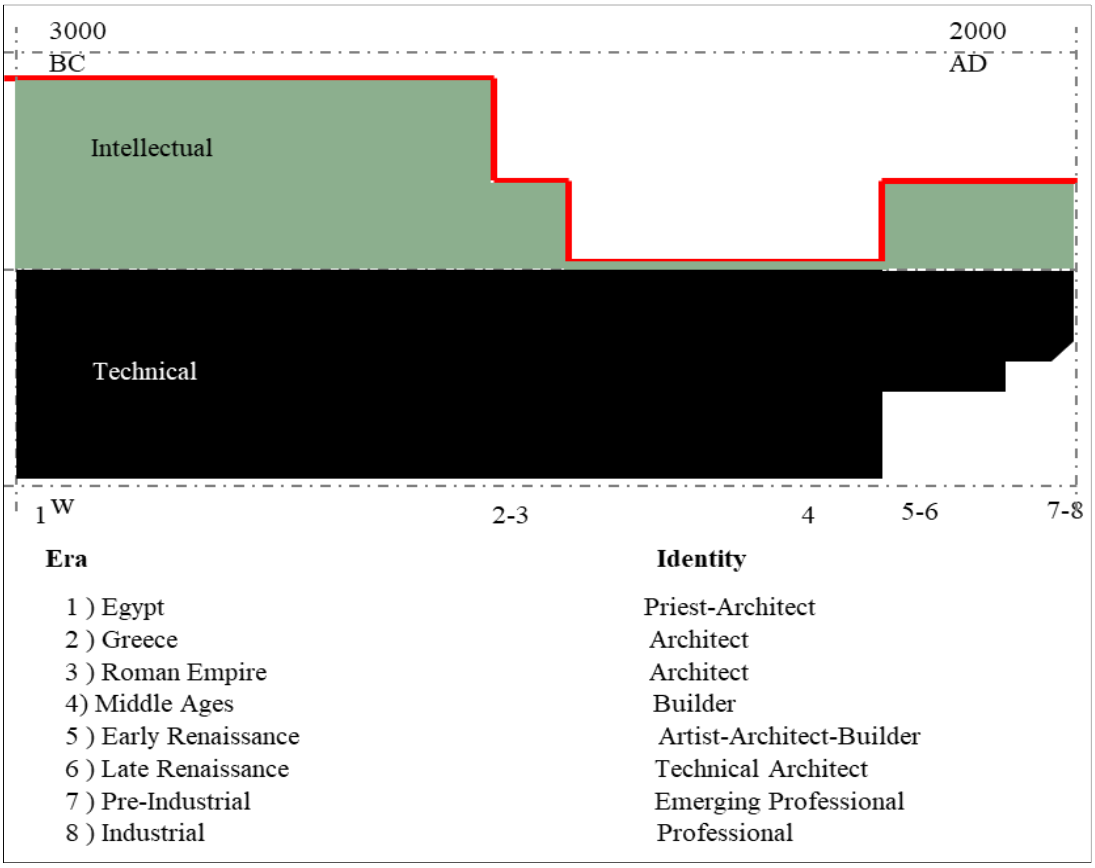

Figure 3: Intellectual and Technical Level of Architect According to Barrow (2000)

So, does it mean that architects no longer need knowledge in other areas? According to Caplicki III (2005), the provision of plans and specifications is not the architect's only duties, but preferably architects can assist the construction process in various ways and phases. So, if the architect is expected to be in this role or as the sole master, he/she needs a proper technical skill in building technology and architectural practice more than the minimal level (Boyle, 1977). Schools of architecture, especially Beaux-arts and Bauhaus as two prominent and different attitudes, had a predominant role in directing architects throughout the time being. Having evaluated them far enriches the understanding of the history of the profession and teaching/learning methods, which will be discussed in this study.

Through the waves of change of the economic system, the twentieth century demanded the architect's role not to be very different from other specialists. He can role as a collaborative figure with other professionals not as ‘master’ as architects well-known for from the past; master-builders. Because of this economic system, if the architect has not acquired specialised knowledge during his education, he could be easily redundant (Boyle, 1977). This makes us think, which types of architects should the architecture schools graduate? According to Nicol and Pilling (2000), “[a]rchitectural education must respond to these changes: it must enable students to develop the skills, strategies, and attitudes needed for professional practice and it must lay the foundation for continuous learning throughout life” (p. 1). Unfortunately, as Worthington (2000) states, there is still a vast gap between an architect's role identified in the schools of architecture and real practice.

Architects need a focused specialisation (de la Maza & Vallejo, 2017) and more expansive essential learning in his practice and education, but “[t]he more we know about the process of designing and constructing a building, the more effective impact we can have on the results” (Binggeli, 2003, p. ix). On the other hand, some architectural schools believe that universities should teach theory to the students, and the industry is responsible for preparing job-ready graduates through training (MacDonald & Mills, 2013). This understanding, if we compare it to Bauhaus as an old school, is opposite to Gropius’ theory as he tried to integrate other disciplines into the curriculum of architecture and to have more training in their education so the architect can have a prominent role in the team (Boyle, 1977), like other interrelated disciplines they should play their role.

2.3 Architecture and Design

Design aims to alter the current situation to a new state. The design process arises for solving a problem through various actions, and like "problem solving, design is a natural and ubiquitous human activity" (Razzouk & Shute, 2012, p. 330). Thus, designing buildings comes from a problem to a solution at the end of finishing the building (Johannes, 1999), because anyone who devises plans of action aimed at transforming undesirable conditions into desirable ones is a designer (Hanington & Martin, 2019).

Design has been defined by Paker Kahvecioğlu (2007) as "a complex and multidimensional activity that involves various skills and dispositions such as *interpretation, communication, problem-framing, research and knowledge integration*" (p. 11). Due to its complexity and the direct impacts on society, the design is considered one of the substantial intellectual accomplishments (Gero & McNeill, 1998).

Some people, such as Lawson (2012), believe that design is a social activity involving various designers, specialists, clients, and consultants. In this holistic process, design players have various roles according to their knowledge. Also, we can have different perspectives on design regarding our understandings. Östman (2005) describes five views that someone can identify design with, which are:

• "Professions (for example architects, industrial designers)

• Disciplines (for example, architecture as taught at a university)

• Cultures (seen as produced, used, and discussed by various agents)

• General or different competencies

• Produced objects (for example, architecture, cars, cell phones)” (p. 54).

When we look for the ideal design condition, it can be “equated to the excellence in the artistic and functional qualities of the design” (Banerjee & Graaff, 1996, p. 185). Also, considering the technicality and realisation this design, thinking of structures, materials, and other building services completes the whole picture.

Architects are most well-known for doing design of the built environment. Therefore, first, the design has to be defined to formulate a better understanding of what architects are responsible for basically. Andriani and Carignani (2014) describe the design as the method of creating objects that have a new physical structure, arrangement, or shape as a result of their purpose. According to them, the target is the function, which requires the whole process and remains the main problem in this progression, while for Gutman (2010b), the artistry nature in design is the core skill for architects, which makes them disparate from other professionals. Knowledge, taste, reason, and judgement would be the usual terms that design has been based on (Jackson, 1995). However, generally, “architects design spaces as well as the constructional systems that enclose and mediate them” (Pitt, 2008, p. 318).

Roman architect Vitruvius has left us the legacy of the architectural design values roughly 2000 years ago. According to Vitruvius, architectural design, at its best station, should have *Firmitas* (Firmness), *Utilitas* (Commodity), and *Venustas* (Aesthetic) (Vitruvius, 2006 trans). Architects still in their design, return to these values to define their work (Jackson, 1995).

Ching (2011), in the book *A visual dictionary of architecture,* complied the definition of architecture from several famous architects as they state:

> Architecture is an art for all to learn because all are concerned with it. - *John Ruskin*.
> Architecture is the masterly, correct and magnificent play of masses brought together in light. - *Le Corbusier*.
> The only way you can build, the only way you can get the building into being, is through the measurable. You must follow the laws of nature and use quantities of brick, methods of construction, and engineering. But in the end, when the building becomes part of living, it evokes unmeasurable qualities, and the spirit of its existence takes over. - *Louis Kahn.*
> Architecture also exists without necessary assistance from an architect; and architects sometimes create buildings which are not architecture. - *Norval White.*
> …the origins of architecture are best understood if one takes a wider view and considers sociocultural factors, in the broadest sense, to be more important than climate, technology, materials, and economy…- *Amos Rapaport.* (p. 8).

From the above definitions, it can be said that architecture is the combination of various aspects. In responding to 'what is architecture?'; Capon (1999b) returns to scrutinising Aristotle's ten categories, which at the late of the classical era reduced to six categories, which are: Quality, Quantity, Relation, Substance, Acting, and Acted upon. He resembles Quality to meaning in designing buildings, Quantity as form, Relation as the context, Substance as materials and construction subjects, Acting as the function and Acting upon relating to spiritual qualities in design. In the end, Capon

(1999b) formulates his principles naming principles of good architecture under two categories and six principles based on Aristotle’s principles, as shown in Figure 4.

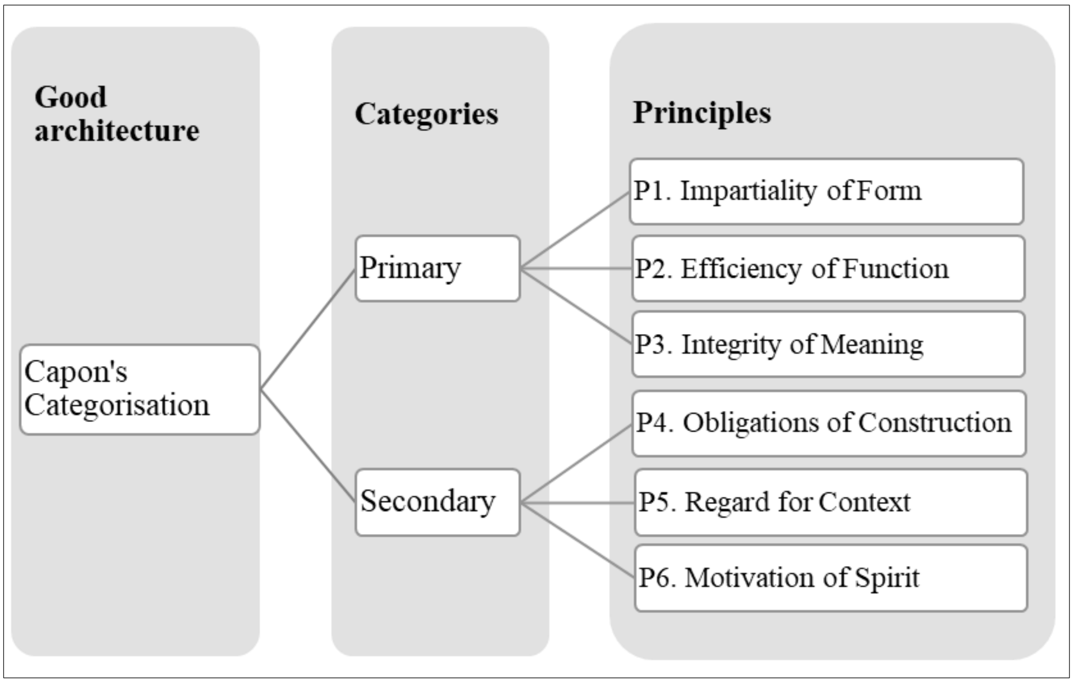

Figure 4: Good Architecture Principles Categorisation According to (Capon, 1999b). Compiled by Author

Capon’s principles worth further discussions; he intends to base a theory through this categorisation, which can better define architecture. In his book *Theory of Architecture, Volume 1*, Capon opens his classifications as such:

> ***Principle 1***: To the element of Form we should bring a requirement for Objectivity or Impartiality, to give: IMPARTIALITY OF FORM,
> ***Principle 2***: To the element of Function we should bring a requirement of efficiency and Economy, to give: EFFICIENCY OF FUNCTION,
> ***Principle 3***: To the element of Meaning we should bring a requirement for Propriety and Integrity, to give: INTEGRITY OF MEANING,
> ***Principle 4***: To give the elements of Design and Construction we should bring a requirement of Responsibility and Obligation, to give: OBLIGATIONS OF CONSTRUCTION,
> ***Principle 5***: To the elements of Context and Community we should bring a requirement for Regard and Sympathy, to give: REGARD FOR CONTEXT,
> ***Principle 6***: To the elements of Will and Spirit we should bring a requirement for Motivation and Conviction, to give: MOTIVATION OF SPIRIT. (Capon, 1999b, pp. 187-188).

In the second volume of his book, Capon compares architectural theories with Vitruvius' definition for architecture; *Firmitas* (Firmness), *Utilitas* (Commodity), and *Venustas* (Delight). Due to his study, he categorized all the descriptions by other scholars under Vitruvius' principles. He questions the link between them and the significance of preserving all the three Vitruvius' design values, which have been described or implied by other scholars and architects. As shown in Table 1 below, every researcher emphasizes these principles, which Vitruvius mentioned almost 2000 years ago (Capon, 1999a).

The table reassures the importance of architecture's technical dimension, it can be said that " 'good' architecture is a solution that would satisfy most design issues in a harmonic manner" (Mahmoodi, 2001, p. 56).

Table 1: Studies on Architectural Design Theory Compared with the Original Vitruvius Categories (Introduced by Capon, Compiled by (Mahmoodi, 2001))

Vitruvius, +2000 years ago	***Firmitas* (Firmness)**	***Utilitas* (Utility)**	***Venustas* (Delight)**
Geoffrey Scott, 1914	• Construction	• Convenience	• Aesthetic
Auguste Perret, 1923	• Material	• Use	• Beauty
Le Corbusier, 1923	• Construction, • Economy	• Utilitarian needs, • Needs, • Living, • Sociology	• Custom/tradition, • Mathematics/harmony, • Conceiving, Aesthetic
Walter Gropius, 1924	• Technology, • Construction, • Structure	• Economy, • Social, • Function	• Form, • Design, • Aesthetic, • Intellect
Ludwig Mies van der Rohe, 1928	• Technical, • Material, • Technical	• Economic, • Functional, • Economic	• Cultural, • Spiritual, • Architectural
ASNOVA, 1931	• Technical plausibility	• Economic feasibility	• Plastic expression
Nikolaus Pevsner, 1943	• Construction	• Function	• Style
Reyner Banham, 1960	• Structural	• Social	• Academic
L. Benevolo, 1960	• Technical	• Social	• Cultural
Christian Norberg-Schulz, (1963)	• Technical, • Material,	• Functional, • Social,	• Aesthetic, • Cultural,

	• Techniques	• Building task	• Form/semantics
Robert Venturi, 1966	• Structure	• Programme	• Expression
N. L. Park, 1968	• Construction, • Physical	• Function, • Behavioural	• Aesthetic, • Conceptual
George Baird, 1969	• Technique	• Function	• Form
Charles Jenks, 1969	• Technics	• Function	• Form
L. Ligo, 1974	• Technics	• Function	• Form
David Canter, 1977	• Physical attributes	• Actions	• Conceptions
R. Krier, 1982	• Construction	• Function	• Form
M. Foster, 1983	• Structure	• Design	• Style

For Bell (2010), at optimum state, architecture is not just an organization of spaces and materials or making a beautiful form, but rather it should have the ability to change the inhabitants' quality, their identity, and even spiritual needs have to be enhanced. For that, architects need physical and metaphysical considerations in their designs. Samuel Mockbee also states in the 'Structures for Inclusion' conference in 2000 that, "[a] shelter can house the body, but shelter the soul" (Quoted in Bell, 2010, p. 77). This metaphysical realm is the output of Vitruvius's ideology that could successfully elevate buildings from the common ground into some higher spiritual position (Jackson, 1995).

Johannes (1999) mentions that design becomes more difficult over time due to fast-technological changes. All the complexities coming to the building industry put more responsibilities over the shoulder of designers and architects. It requires them to be more knowledgeable in the technicality of buildings and incorporate these physical entities into the environment ecologically. Architects, more than anybody else, shape the environment we live in, so their products, in the same way, should be the solution for the problems that come from that environment (Norberg-Schulz, 1966).

2.4 Challenges of the Profession

As a profession, architecture has many challenges, which are interrelated highly intricately with other outside conditions such as the overall economic situation of society, culture, and political situation. Whenever the financial position is placid architectural profession and skills alike receive more attention and confidence (Gutman, 2010a). While vice versa, unfortunately, it is also the reality of this professions. Moreover, Gutman, Cuff, and Bell (2010) believe that:

> No other major profession is so often seized with worry about its own future as is architecture. The reason for the concern is substantial, given several factors about the field. For example, some of its work can be handled by other professions, such as engineers or interior designers. (p. 33).

It is one of the reasons, which has caused such fluctuation in the body of the profession. Other contributors in the building industry have limited the authority of architect, on the other side. Another reason that may make the future of the profession uncertain is the rapid change in the design trends (Gutman et al., 2010), mainly due to widespread social networks and other advertisement agencies.

Gutman (1988), in his book *Architectural Practice: A Critical View,* lists ten factors, which might have caused the change in the individual experience of architects, which are:

> (1) the expanding demand for architectural services; (2) changes in the structure of demand; (3) the oversupply, or potential oversupply, of entrants into the profession; (4) the increased size and complexity of buildings; (5) the consolidation and professionalization of the construction industry; (6) the greater rationality and sophistication of client organizations; (7) the more intense competition between architects and other professions; (8) the greater competition within the profession; (9) the continuing economic difficulties of practice; and (10) changing expectations of architecture among the public. (p. 19).

The issues mentioned by Gutman (1988), which is from three decades ago, are more obvious nowadays. Technological changes are more rapid and problems like overpopulation, and randomly growth of cities in some places of the world, and issues from the profession of architecture actually surpassed the problems existed in the last century.

This wave of professional change, fundamentally, dates back to the nineteenth century; to the establishment of the Royal Institute of British Architects (RIBA) in 1877 (Kostof, 1977). The duality in design appeared as the preference has been given to the intellectual activity, and it has been divorced from the making process. The outcome was the craftsman's position in the building's overall design process was diminished (Kostof, 1977). For this reason, “architects began defining themselves as professionals in the 19th century, designing and building have been as two distinct fields, and architectural education treated students accordingly” (Branch, 1994, p. 57). We may perceive the nineteenth century as the century of emerging innumerable architectural styles, but practical and professional transformations are fundamental. One of the significant changes, which is incessant until nowadays, is the departure of the ‘artistic’ and ‘technological’ side of architectural design (H. Davis, 2008).

The nature of art and architecture has a common ground, while unlike artists, architects do not have the opportunity to work with materials and objects of their imagination; instead, they should think abstractly of these materials through drawing and proposing them as architects may not have the chance to physically involve in erecting bricks and putting mortar over it (Schörpfer, 2012). Because architecture is not merely “piling materials on top of each other to produce buildings but the thoughtful manipulation of those materials based on ideas which are, however, historically changeable" (Brawne, 2003, p. 12). The artistic side of design still has popularity, as there are/were architects, such as Zaha Hadid and Rem Koolhaas, who consider(ed) themselves as artists and produce(ed) artistic forms (H. Davis, 2008). Furthermore, some students intend to study architecture because of its artistic side, the same as the woman who was interviewed by Gutman, explained: "I went to architecture school because I was interested in the art of architecture. But there is no chance to do any design work here. I think I will go back to painting, which was what drew me to architecture in the first place" (Gutman, 2010b, p. 45). Indeed, architecture is a combination of art and science, 'the art and science of building' is the definition of the professional architect's role (Dutton, 1991).

Consequently, being creative is not enough, but practicality is equally essential (Maritz, 2008). In this notion, architects have a dual identity. One identity as an artist is related to visual quality and aesthetics of buildings, the other identity as a practical person, which is about how to design and make buildings stand up, endure, and work. According to Gutman (2010b), this dual identity situation is the mother of almost all difficulties encountered by the architects working in firms. Balancing both sides for architects seems to be a confusing task and make them be under the expectations of the clients and society, because "[f]rom the client we hear constant complaints about the architects' lack of ability to satisfy him, from a practical as well as from an aesthetical and economical point of view" (Norberg-Schulz, 1966, p. 13). This might be true for nowadays, too. Furthermore, as Bell (2010) mentions, the limit of architecture should not stop in the building role alone, but through extending this boundary to embrace both pre-form and post-form, i.e., material and nonmaterial culture can have a positive effect on a design from objects to people. This can be taken into considerations to redefine the role of architecture in society nowadays.

The main criticism about designers, mainly architects, is the inability to meet their clients' practical needs (Branch, 1994). When architects lose this side of design, it means that they miss the main subject, which is the materialisation of their imagination, because "the heart of what we [architects] do is the art of making" (Kirkland, 2012, p. 51). The subject of aesthetics is essential for architects, but we should keep it in mind that the architectural environment in our daily life demands more 'practical' competencies (Norberg-Schulz, 1966). It seems the repercussion of neglecting the practical side started to appear when "the British Architect's Journal reported that the number of architects filing for unemployment had increased faster than in any other profession" (Cuff, 2007, p. 23), due to mismatching the architect's design and technical skills with the market needs.

They are contending these values practiced by modern architects, S. A. Moore and Webber (2008) classified architects under three subdivisions accordingly as: "*production architects* as those who strive to serve the varying interests of their clients; *star architects* as those who serve the interests of art; and *eco-social architects* as those who serve the marginal interests of society and/or the environment" (S. A. Moore & Webber, 2008, p. 289). All these types of architects seek a place to do design as the majority of architects are interested in doing design "even though they're not particularly gifted with it" (Gutman, 2010b). While in all cases, the rate of integrating architectural science in design remains unsatisfactory. According to Demirbilek and Demirbilek (2007), this situation produces inappropriate design, which leads to "environmental problems such as diminishing resources and air/land/noise/light pollution, which in turn have negative effects on lives of human beings and animals as well as nature" (p. 86). It is a serious matter which, unfortunately, is underestimated by scholars. Indeed, many issues arise from this separation of architecture and the technological world, which are more important than the study of stylistic distinctions as they took a considerable amount of the architectural argument (Pelletier & Pérez-Gómez, 1994).

Dominating the subject of humanity in architecture schools in the twentieth century, under-educated students of architecture focused mainly on design and limited knowledge on technology and construction knowledge (Branch, 1994). For that reason, Gutman (1996) describes the profession of architecture as 'weak,' and he does not hide his concern that "architectural practice remains a troubled and beleaguered endeavour" (p. 89). For Gutman, the problem comes from these theoretical issues are serious and may threaten the future of the architectural profession. Designing durable buildings, economical in construction, environmentally friendly, keeping buildings on schedule, and being well-maintained can be handled by engineers and contractors. However, the architectural profession's merit in this process is coordinating all concerns, as mentioned above, with aesthetic consideration. The overall design should "[r]espond to the canons of order, form, function, and convenience, all in a single solution" (Gutman, 2010a, p. 41).

In this extremely rapid-paced world of technology, it seems not easy for architects to keep up. Also, architects have obvious problems even in fundamental science awareness. As a result, many architects, except some of them, have difficulties in the structural methods, as an example. They stay in the conventional way of thinking for what they know previously (Herbert, 2016). Responding to that "[w]ithin the last decades, integration of architectural science knowledge into the domain of architectural design studios has been of growing concern and importance, particularly with accelerating global imperatives of the energy crisis, environmental pollution, and climate change" (Demirbilek & Demirbilek, 2007, p. 85).

As long as the ultimate goal of a good design is in its materialisation and realisation, the process of this alteration from a communicative state (drawings) to a substance is crucial "[d]esign is an activity that responds to human needs, maintains the world and leads to an executable work, developed through reciprocal action of thinking and making" (Dozois, 2001, p. 22). Putting it simply into words, we live in buildings and perceive them too. Therefore, architecture should respond to people's needs, not just release based on architects' creative impulses (Sanoff & Toker, 2003).

To realize in the 'highest purpose' of building, which is the instinctive ambition of architecture as not just a piece of art, Johannes (1999) redefines Wolfgang Goethe's remarks. Goethe proposes four methodical steps to be obeyed before buildings become a work of art, which are:

> 1. Knowledge of the material: "The art of building requires a material which can be used in stages for three purposes. … The building artist familiarises himself with its properties and either allows himself to be ruled by those properties … or he forces the material …" into complicated structures by means of mechanical knowledge and insight.
>
> 2. The use of the building: "… being able to accomplish what is necessary with convenience."
>
> 3. Harmony in sensual perception and physical motion: "The difficult and complicated theory of proportions, by which the building and its various parts achieve their character, comes into play here."
>
> 4. The poetry by which a building really becomes a work of art. "which … undertakes to overwhelm the senses and raise an educated spirit up to astonishment and delight; this can only be produced by the genius which has made itself master of the other necessities; this is the poetic part of the art of building, in which the fiction is properly deployed." (Johannes, 1999, p. 7)

To achieve understanding this, architects need to distinguish between several layers as *personal, cultural,* and *universal* layers.

> We have, for instance, personal spatial preferences: some like the cosy, some the grand. Additionally, our personal space, the distance between ourselves and strangers in which we feel at ease varies from culture to culture… Colours have similar universal effects, despite being overlaid with cultural associations and strong personal preferences. (Day, 2017, p. 10).

From the above discussions, it can be said that what Vitruvius has mentioned as the definition of good architecture two millenniums ago is still valid (Teymur, 1992), while, despite all the changes the economic recessions triggered in the 1970s demanded some other values added to Vitruvius' principles of 'good architecture' including economy like energy consumption, and environmental considerations such as sustainability and ecological subjects (Koranteng, Afram, & Ayeke, 2015). When 'knowledge of material' can solidify how to make buildings stand up and bear environmental effects (Firmitas). 'The use of building, sensual perception, and physical motion' is about how a building should function (Utilitas). Emphasizing the 'art side of buildings' is notifying the need for aesthetics (Venustas).

After the industrial revolution and industrialization, architecture, like other professions, became a commodity for sale, especially in the mid-20th century and on. Articles written under the title 'architecture is a business' by Silverman, E., in 1939, or titles as 'how to run an architect's office' and so on in architectural publications are evidence of the reality that "the era of gentleman architect was over" (H. Davis, 2008, p. 280). Instead, the architectural product is mostly marketed for money, examples for this all the mass construction of residential, commercial, etcetera, and buildings prepared as commodities selling to people without considerations to the architectural values described above. This was caused emerging the international style in architecture, beginning with ‘The International Style’ exhibition held in New York by Philip Johnson and Henry Russell Hitchcock in the 1930s (H. Davis, 2008).

2.5 Architectural Education

Dating back to the 19th century, the situation dramatically changed concerning educating architects. In the late 19th century, apprenticeship's cultural model started to change to training in higher institutions (M. N. Woods, 1999). From this point and on, architects' formal education has begun, which has focused on project-based learning.

Challenges in the market economy made people to think, what architects do can be seen as a product. This understanding leads education to face reality and future uncertainties. Research conducted by Charalambous and Christou (2016) shows that marketability and communicability of design products are equally significant as the other design values of “functionality, usability and beauty” (Charalambous & Christou, 2016, p. 381). However, architecture schools rarely attempt to highlight this side in education. Conversely, the focus is mostly on solving design problems of some building types studied during semesters (Perdomo & Cavallin, 2014), without a broad expectation outside the school vicinities. The disappointment in the profession of architecture resulted in discontents in architectural education. This situation of uncertainty in architectural education could be resolved if the educational system and architects pay more attention to both theory and practice according to Mahmoodi (2001), as well as keeping an eye on the inclusion of market needs into architectural education.

Broadbent (1988) sheds light on the tensions between the profession and architectural education at that time. He separates the architect's different roles as *'the architect as designer'* and *'the architect at work'* according to the design process from the beginning until the construction stage. For these differences, Broadbent revisits the learning model of architects, and he classifies it as *'theory in a classroom and design studio'* and learning during *'practice'* (Broadbent, 1995). This approach has less relation to content but is rather about how students of architecture should be taught and responded to different situations, without merely focusing on a particular project (Ganapathy Iyer, 2018). So, it is necessary to guide students learn design as a process. The emphasis has to be on how possible to alter design from a product to a process-based approach, and making the architecture students develop a better understanding of the architectural practice (Lawson, 2012). Shifting attention to seeing architectural design as a process-based activity, according to Callicott and Shell (2000), should have priority over other approaches such as 'craft of making' to achieve the highest possible outcome. In this notion, Ganapathy Iyer (2018) questions whether we look for an architectural design outcome or a qualified student at the end of this process, and this should be questioned for architectural education purposes. Because as Teymur (2001) mentions, the main aim of architectural education is "the education [and] training of future architects,…[and] helping to bring up 'good, educated, citizens'" (p. 4), and this can be achieved through a process after all.

To understand architectural education's basic and historical models, we should undoubtedly turn back to the Beaux-Arts and Bauhaus, which their influences are still present nowadays in architectural schools and institutions (Sahai, 2020). In the seventeenth century and for the first time in France, architecture was one of the fine arts incorporated into school to be studied. Before, building aspects had been shared by arts in an apprenticeship model for those working in buildings such as master builders or craftsmen (Cret, 1941). *'Académie Royal d'Architecture'* as a modern architecture school began in 1671, then led to the 'Académie des Beaux-Arts' and later changed to *'École des Beaux-Arts'* in Paris. The education of architects in École des Beaux-Arts was based on apprenticeship model and architecture was learned through practicing and making drawings of existing buildings (Newman & Vassigh, 2014).

The experiential learning model was applied in this school in France. In Beaux-Arts' model, project-based learning by doing and mastery ability had been highly emphasised "where students are considered the recipient while the studio masters as the provider of knowledge in a competitive atmosphere" (Samsuddin, 2008, p. 29). Students were assigned in the ateliers to work on their designs supervised by a prominent architect or a teacher like a patron (Crinson & Lubbock, 1994). Thus, the design studio model started emerging. Design studios had been a place for discovery, integration, and sharing knowledge between students and tutors. In this studio design, the final drawing projects hanged to be judged and gave critics by jury members and guest architects, without the presence of students (Lackney, 1999).

The studio project dominated the overall education in Beaux-Arts. All the other courses and subjects taught as lectures were supplementary to it and separated from the design studio. This separation made the design studio seen as the only environment to train young architects (Crinson & Lubbock, 1994). However, these schools' appearing resulted in investigating the architectural education in many ways, as some people criticized teaching design and believed that design could not be taught (Michael Richards, 2009).

Bauhaus education model in architecture started after the First World War, equipped with new concepts different and even challenging to the traditional school of architecture, Beaux-Arts. The main approach of Bauhaus is very much interconnected to the world of practice and learning from it. Interdisciplinary approach encouraged in the design studio, in a way that the school leaders believed in social learning. Bauhaus took inspiration from the social theorists who believed that unskilled people could learn intricate knowledge through participation in the practice environment (D. C. Phillips & Soltis, 2004). From this perspective, Bauhaus "allows discovery, self-regulated, and hands-on learning using collaborative and interdisciplinary practices" (Samsuddin, 2008, pp. 29-30).

The applied curriculum in Bauhaus arranged in a balance between practical and formal instruction (Gropius, 1965). This method urged students to learn by doing and involving in both arts and crafts. The conglomeration of other disciplines in the educational model enhanced students' technical skills, creativity, and learning personalities (Farghaly, 2006).

Architectural students had to spend six months studying and learning "fundamentals of form and materials by making arts and crafts" (Carpenter, 2004, p. 66). Students should continue studying design and building components for three years; in a way, they had to build what they designed in all the stages of learning (Ascher, 2015).

Bauhaus founded its specific pedagogy, which is based on both manual and mental skills. For that, the ‘practical instruction’ was specified in studying various building materials such as clay, metal, glass, stone, textiles, and so on while the formal instruction subdivided into three categories as “aspect (the study of nature and the study of materials), representation (the study of plane geometry, the study of construction, draftsmanship, and model-making) and design (the study of volumes, the study of colours, the study of composition)” (Gelmez, 2016, p. 14).

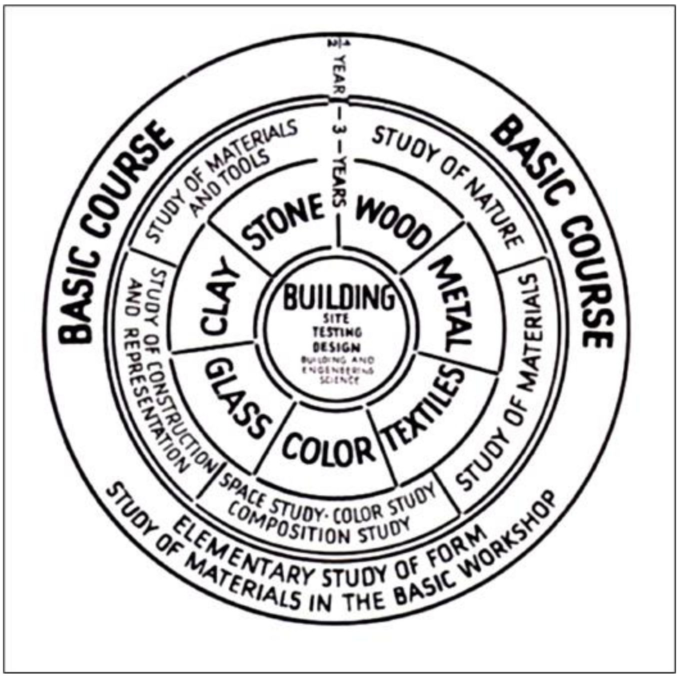

Figure 5: Bauhaus Curriculum, 1923 (Lupton & Miller, 1999)

Gropius believed that “[c]onstruction should be taught with design, for they are directly interdependent…Students learn to design better when first encouraged to explore, try, reflect upon, and integrate design and construction” (Carpenter, 2004, p. 69). It was all happening in the design studio, which converted into a learning community.

According to Friedman (2003), the tradition of craft-based and art-based education, which had produced skill-based education, is the extension of the Bauhaus pedagogy, as the students were involved in making what they designed in the form of artefacts. However, this pedagogical tool used in Bauhaus in the form of master-apprentice (teacher-centred) could not fulfil all the design professions (Ghassan & Bohemia, 2015). In the Bauhaus community, students have the chance to have active participation rather than passive listening. Another concern in the Bauhaus environment designed learning had little connection with the historical culture of architecture (Samsuddin, 2008). Instead, more focus was on learning from nature and materials, emphasizing self-expression, and abstraction (M. Davis, 1998). Thus, students of architecture in Bauhaus could expand their technical knowledge horizon in various disciplines "[t]hese are hands-on learning experiences through a collaborative process that prepare more employable graduates" (Samsuddin, 2008, p. 29).

Unlike nowadays that can be in different parts of the world, architects of Bauhaus era had more knowledge that is technical and more involved in the construction process. The industrial age, especially at the beginning of the 20th century and growing modern architecture, dramatically changed architectural values; the aesthetic of architecture was representing the aesthetic of the machine, for instance (Jacobus, 2009). The separation of the two significant poles in architecture, which are 'art' (the creative part of the architect) and 'science' (all the regulations and constraints imposed by materials and engineering aspects), became crystal clear in the 20^{th} century (H. Davis, 2008).

Education in schools of architecture "has been undergoing a severe process of bureaucratization, professionalization, standardization, etc." (Shatarova, 2017, p. 28). This attitude mismatches architectural design's holistic aim because "architecture has not only an instrumental purpose but also a psychological function” (Norberg-Schulz, 1966, p. 22). Furthermore, Cuff (2007) mentions the significance of sociology in education medium and explains that having this sociologist teaching in architecture brings up architects with sociology awareness under the guidance of the next generation of ‘social thinkers’. It adds new awareness dimensions to the education, practice, profession, and practice of architecture towards its future.

Architectural education may not always stay beside the profession and practice (Carpenter, 2004). As a result, the schools of architecture are stepping back from practice; however, practical skills are still on the top list by the profession of architecture (G. Brown & Gelernter, 1989). According to Gross and Do (1997), architectural education is hardly perfect, and researching architecture has not been paid attention by researchers. All the time and concentration of students are on creativity in design, which outweighs a design that works in the real world. Students of architecture nowadays imitate the architectural work of star architects without thinking of the local contextual considerations and client needs. On the other hand, other students imagine the design as an inner pleasure rather than a challenge to solve different social and technical considerations in design. It seems that the overall system of education “completely distanced ourselves from the idea that a school should be a temple of thought as well as a generator of critical thinkers and ingenious ideas” (Shatarova, 2017, p. 28).

Separation of artistic and scientific subjects independently in architectural education poses a real challenge, running parallel to the other domains as craft-based, technological and sociological, and academic domains (Salama & Wilkinson, 2007). That is why a holistic understanding of teaching/learning design in architectural education faces more contests (Ganapathy Iyer, 2018). Another challenge faces architectural education is disintegrating knowledge (lectures) and application (design studio), which “knowledge and application are learned separately; knowledge occurs in the formal lecture class, and application occurs in the design studio” (Salama, 1995, p. 5).

Researchers are disclosing the inadequacies in architectural education. One of these studies listed several principal problems, as, according to Abdullah (2006), the issues have to be evaluated first. Then challenges should be presented if we want to target an improvement goal in architectural education. For this reason, he listed these problems, as shown in Figure 6 below.

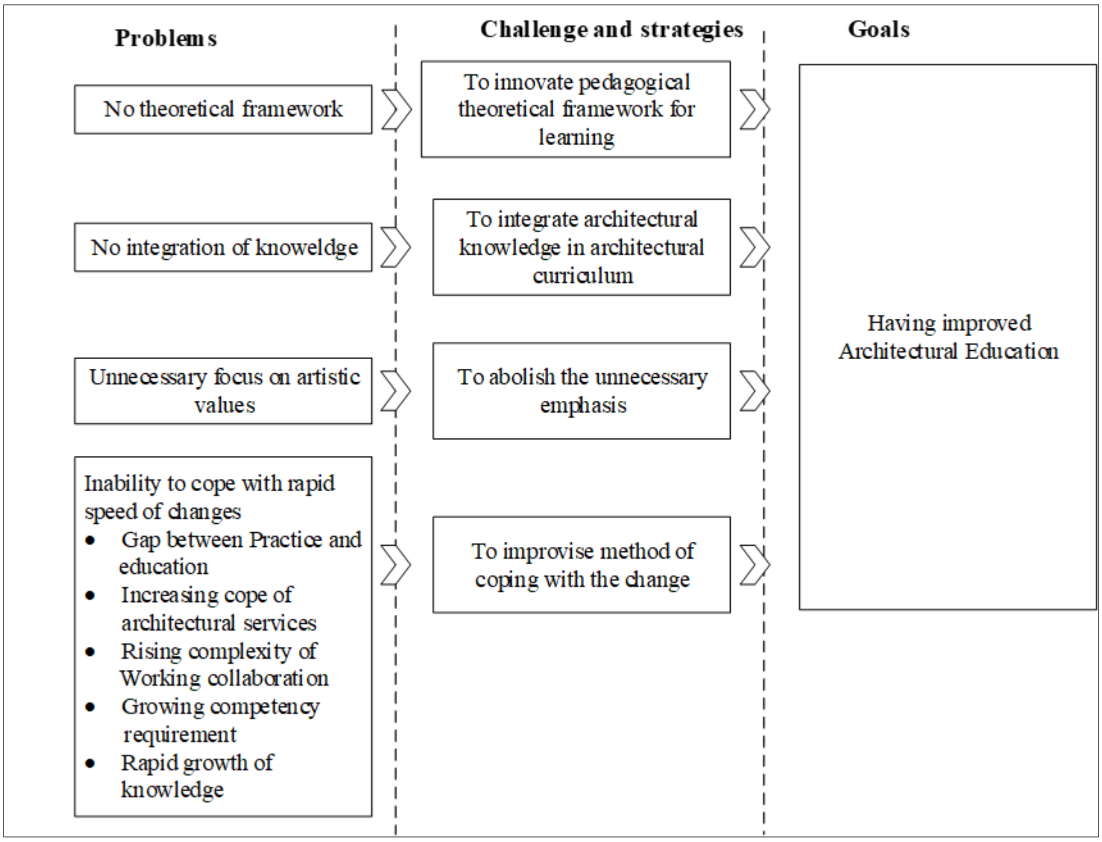

Figure 6: Problems, Challenges, and Goals of Architecture School, Adapted from (Abdullah, 2006)

Architectural education, according to Mahmoodi (2001), should look far beyond the needs of profession and practice, towards a more holistic approach in serving a public purpose. Then it will be possible to think whether architects are ready to fulfil the actual purpose of architecture, which is satisfying the aesthetic, social, and physical needs of society (Farahat, 2011).

Teymur (1992), in his book *Architectural education: issues in educational practice and policy* points out to the significance of architectural education and the role of educators and says:

> For genuine educators, (i) Education must be more important than architecture, and (ii) Education must be ahead of architectural practice 'good architecture' does not guarantee 'good education' in the same way that good education , though necessary, may not be sufficient to secure good architecture. (Teymur, 1992, p. 38).

Around the 1960s and on architectural schools' focus shifted away from graduating practicing architects to studying architecture as hobby, who people may study for their intrinsic purpose (Michael Richards, 2010). Besides, "[t]he diversity of degree titles and the lack of uniformity between programs have confused embarking students, accreditation standards, and faculty attempting to secure long-term appointments in higher education" (Michael Richards, 2009, p. 45). It resulted in multi-variety subjects infilled the curriculum of schools of architecture, and these subjects, according to the geography or cultural aspects, have different priorities. Unquestionably, schools of architecture choose to input their desired subjects in their curricula, as some of them narrowed down the focus merely to just a vocational matter rather than directing to more diversity pathways (Stansfield-Smith, 1999). While, this subject seems to be bounded to geographical locations and the market needs of these countries nowadays, because the role and skills' expectations from architects are different from one country to another.

A survey was conducted in the architectural schools in Canada in 2015 by the ACSA (Association of Collegiate Schools of Architecture), a non-profit association, dealing with the issues in architectural education, architectural research, and profession in the United States of America and Canada founded since 1912. The survey showed the subjects' focus of the schools. The priority has been given to "ecological design; history, theory, and criticism; building technologies; and digital fabrication" (ACSA, 2015), illustrated in Figure 7. So, the technical subjects are also emphasized, yet, how these courses are taught and learned has not been clarified in the survey.

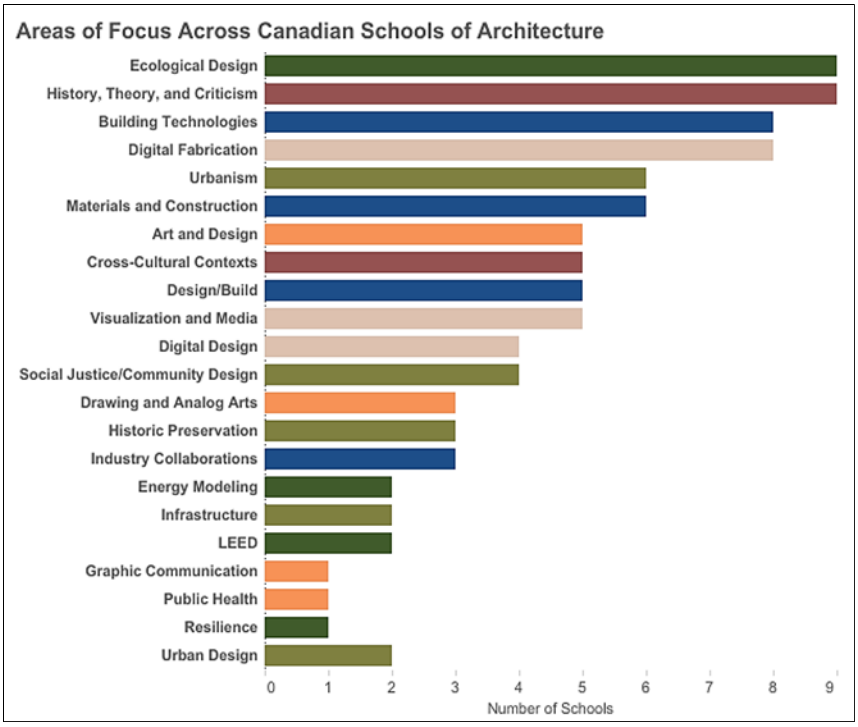

Figure 7: ACSA's Survey in the Canadian Architectural Schools (ACSA, 2015)

The subjects' priorities may be different from country to country, and the load weight of these courses are different. The process of becoming an architect is also another controversial subject among architectural accreditation organizations and countries. The duration, internship, as well as exams are different from country to country.

In some countries like the United States of America and China, becoming an architect takes ten years, including all school education, internship, and the final exam. For instance, in other countries such as Brazil and Turkey, it takes just four years without requiring a training and final exam, such as shown in Figure 8.

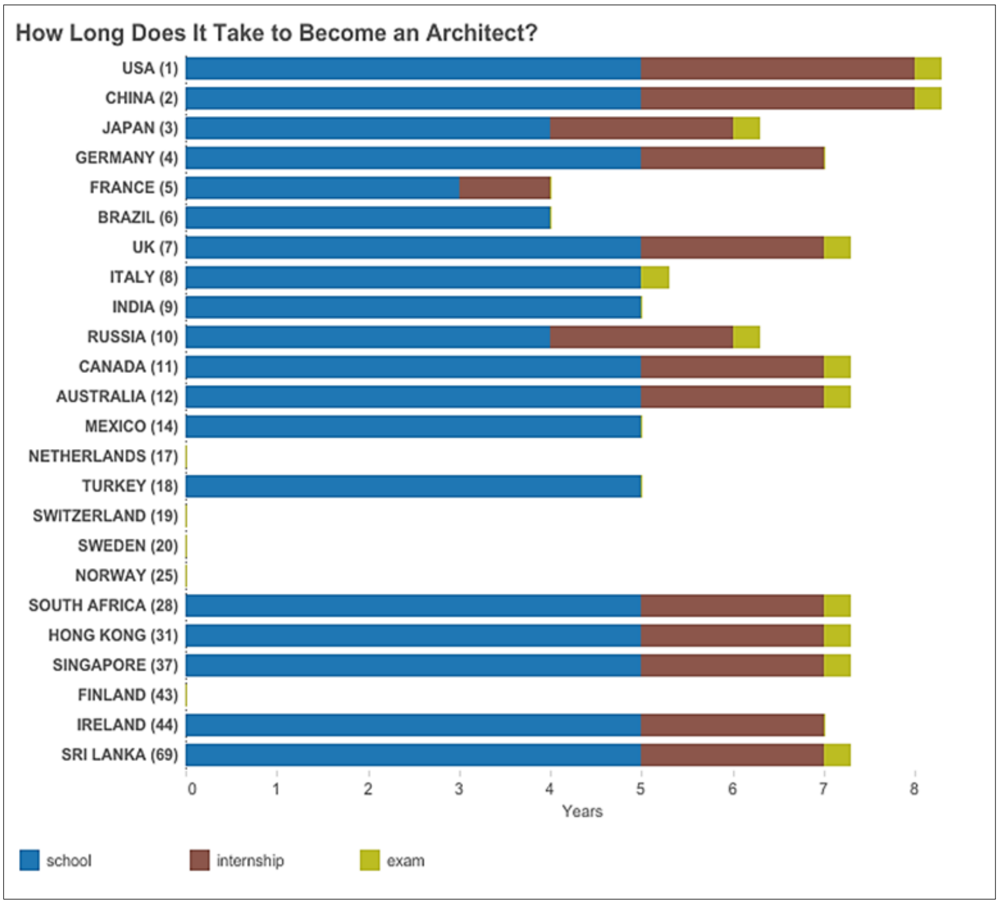

Figure 8: Process of Becoming an Architect in Different Countries (ACSA, 2013)

2.5.1 Design Studio

The design studio model's origin dates to the atelier apprenticeship practices in the from Beaux-Arts, which was the absolute method of teaching/learning art and craft activities. Young apprentices worked and learned in these wide collaborative settings, opposite to nowadays secluded school environments (Lackney, 1999).

In the design studio, students acquire theoretical and practical knowledge, which benefits their design imagination. Design per se is a constructive activity, as for a long time, "… mankind has created new objects and processes (more or less physical), and has developed ways of doing this" (Glanville, 2006). In the tradition of design education, the design studio is the core subject of the constructivist approach practiced by architectural schools; it works together on design in a shared space (Sweeting, 2014). Anderson (2011) addresses design studio as "a place where research, experimentation, discussion and the testing of ideas can take place before they are put into action on site" (p. 4). Also it is a place "that enables the design to be developed both far away and far in advance of its actual implementation" (Anderson, 2011, p. 9). In this learning place, students and teacher(s) keep their dialoguing around design critiques; that is why design studio is considered the backbone of architectural education (Uluoğlu, 2000).

The design studio has a long past in design education, and it has the same significance as before. Still, it is a place for gathering like-minded individuals, and constructive criticism occurs, which helps develop design ideas and proposals. Design studio can serve its fullest purpose when it can be used together with an appropriate pedagogical approach. Unfortunately, like Goldschmidt, Hochman, and Dafni (2010) mention, there is an uncertain pedagogical method in the design studio. Furthermore, Yürekli (2001) reports that because the design studio is an ongoing milieu, it is like a continuous boiling thing or a black hole where things (ideas) come into it so quickly that it cannot be well-realized; thus, it is not the place to expect the best ingredient to bake a perfect cake. Some instructors use their prior pedagogical approaches on their engaging educational experiences because most of these instructors do not have a pedagogical degree.

In the design studio, students can demonstrate what they learned by talking about and making it to learn-by-doing opposite to what is happening in theoretical classes. It is not a sport to watch when it comes to learning. Students do not really learn much from merely sitting in class and listening to instructors, remembering pre-packaged tasks, and spouting responses (Latham, 2013), but they have to be players in the learning process and do practicing it.

Whenever mentioning architectural education, the subject core revolves around design studio; since its emergence, it is still considered the heart of architectural education (Akalin & Sezal, 2009; Cossentino, 2002; Dutton, 1987; Salama, 2005). For Schön, the design studio is “a virtual world that represents the real world of practice” (Schön, 1985, p. 32). Students and instructors engage in reflective conversations about specific situations (Schön, 1991). These conversations are essential to set design as design; without it, “you’re not doing design, you’re doing problem-solving” (Glanville, 2014). The focus of this research rounds beyond seeing design as a problem-solving, but rather as a system, which is in-lined with cybernetics. In this manner, the design studio is the place of this cyclic system from problem definition to problem-solving and looping this process through conversations between students and students and instructors towards second-order cybernetics. Schön (1988) resembles the design studio as the marriage place of art and applied sciences. Design studio improves the ‘artistic’ quality of architectural design and enhances students’ perception of structural imaginations and analysis (Eigbeonan, 2013). One may ask why design studio education is in that much significant position in architectural education. As partly answered, it is much more than a mere space to teach students. The nature of this method impacts many other aspects, which implicitly and explicitly enriches the learning process.

Students in the design studio learn how to practice through using its media and tools under the observation of a master studio, who guides, advises, criticizes, and questions mostly like a coach rather than a teacher (Schön, 1988). Furthermore, Donald Schön discusses two significant concepts, which their pinpoint starts from the design studio; 'reflection-in-action' and 'reflection-on-action,' "[w]hile 'reflection-in-action' corresponds to thinking on feet, 'reflection-on-action' implies reconsidering a practice later. The former one is related to considering experiences, feelings, and theories in use… the latter one signifies thinking about previous actions" (Schön, 1991). This understanding has a vital role for practitioners in the field of design. For this reason, the design studio can be a place for the designers that both pre-design and post-design ideas are generated.

In this environment, students learn and experience the architectural design process (Lawson, 2005) through various activities and socializations and communications with peers and tutors about their design ideas, which leads to many group discussions and critic sessions (Samsuddin, 2008). For this reason, the design studio owned its own culture to be a place for multiple actions such as discussions, experimentations, and testing ideas as a pre-stage for the real on-site projects. The assembly of those like-minded people "capable of collaboration and constructive criticism assists the development of architectural proposals and the fostering of mutual preoccupations" (Anderson, 2011). Furthermore, students move towards finding design solution ideas or concepts for ill-defined design problems (Cross, 1982) to combine both practical and theoretical knowledge to reach the prospective design (Teymur, 2001).

Paker Kahvecioğlu (2007) believes that design studio is potentially more than just a place of sharing and transferring knowledge, but is also a social milieu, which boosts creativity. Regardless of all the differences in educational strategies, critics, and knowledge transferring methods, the design studio still performs the best in terms of its purpose, leading to students 'knowing how to design' and enhance the design process. The main difference between this place to other settings, like classrooms, is that students spend most of their time during class time and in their free time in the design studio (Demirbaş, 1997). Students may learn about specific knowledge of architectural subjects such as history, environmental controls, structural matters, and types in class instructions, while, design studio, through its role as the hub in architectural education, becomes the place for applying this knowledge, evaluations on design, and developing alternatives. However, what remained as a challenge is how to integrate the knowledge learned in class-lectures into the design studio experience (Gross & Do, 1997).

In this way, design studio provides a unique psychological atmosphere due to the socialization process occurs among students (studio peers) when they learn design (Parr & Townsend, 2002). It becomes the place for deep dialogues and collaboration on open-ended problems. In this way, studio-based learning can be seen as an effective method for learning critical skills about design and enjoyment (Roberts, 2004). As a result, in this place, students can learn many skills and practices such as visualisation and representation to enhance their design abilities. This socialisation and cognition process makes the design better understood by students, especially if it is correlated to technology (Samsuddin, 2008). These specific features, which design studio can be recognized for, lead to a distinctive culture.

The two basic activities of a design studio are design thinking processes and critics on the design concepts. Communication and thinking processes are the dominant features of the design studio. The design studio environment has to be supportive and interesting to function as expected (Demirbaş, 1997). For Zhu (2013), despite all the ambiguity in the definition of the design studio, but it is the milieu where students can learn to 'think architecturally', which includes learning skills, the language of architecture, and thinking of problems and solutions, which is highly essential for the profession of architecture.

Koch, Schwennsen, Dutton, and Smith (2002), in their book *The Redesign of Studio Culture*, point out the significance of design studio to architectural education and other fields alike. They think this is because of the interaction between students and instructors during the design process, as students can receive feedback immediately on their designs. However, this is not ideal in their opinion, but there are many obstacles, existed in the design studio which can be mentioned as such:

- Morals and traditions of the design studio are very dominant on students' education, due to having their own culture.
- The design studio's culture resists changing.
- Presence of ignorance and arrogance as the result of seclusion from the outside world.
- Neglecting that design is a process, but instead, the focus remains on the final product.

- Graduates of architecture obtain a narrow base knowledge as the result of the factors mentioned above.

Samsuddin (2008) believes that architectural students' isolation in the design studio has a great influence on the isolation of architectural education from other disciplines. In this regard, he believes that the design studio produces narrow-minded architectural graduates prepared for an unrealistic world and exclusion of others. The output risks the collaboration between architecture and other related fields, especially in complex projects.

Furthermore, other researches, as Shahamat, Nadimi, Gharehbaglou, and Keramati (2019), Crowther (2013), and Ward (1990) describe an existing ‘hidden curriculum’ in-studio learning, which might have an undesirable impact on the outcome of teaching and learning. According to Ward (1990), this ‘hidden curriculum’ is like a ‘mastery-mystery game,’ which is still effective beyond all the design studio rules and regulations, making studio learning challenging modifications and improvements. This situation results in emerging implicit content in the studio, which teaching skills, the architectural language, and problem approaches are all made indirectly. The method looks confusing, and the learner may not have a clear idea of what will be learned next. Moreover, he/she gets confusions about the meaning of what is taught, which leads to the learners' spending more effort to make the events understandable and available for them (Schön, 1981). Another sensitive issue is that the teachers in architecture do not have a pedagogical degree or trained as a teacher. Indeed, “[t]hey generally come straight from practice and tend to replicate their own student experience while learning on the job, and therefore tend to lack understanding of the theory of educational processes" (Hassanpour, Utaberta, & Ani, 2013, p. 34), and this is another omnipresent problem in the design studio.

Bibbings, Bieluga, and Mills (2018) criticize the design studio model as an isolated body from other related disciplines. They see the construction industry (where architecture can have a significant role in) must be integrated and collaborated in teamwork, communication, and feedback. In contrast, the design studio teaching leads future architects to design with the least "input from other design colleagues or other built environment professionals" (Bibbings et al., 2018, p. 377).

Another serious issue in architectural education is the lack of integration between design and technical subjects in the design studio, which detaches from the world of practice (Buchanan, 1989). For Buchanan (1989), detailing and construction subjects are taught inappropriately in architectural education and specifically in the design studio. Some details and materials are exaggeratedly taught without highlighting the influences on the other aspects of design. Similarly, Ridgway (2003) points out the weak link and integration between technical knowledge, delivery in the technical-related courses, and the design studio. It had led to a separation in the subjects of the curriculum of architecture. For him, this separation clouds the understanding of architects' skills they need, which should be based on an integrative principle among all the study subjects as arts, technology, and sciences. Architects should have awareness in linking different knowledge domains, as this needs critical thinking and the ability to solve problems, especially ill-defined problems, related to the built environment. He suggests that technical knowledge has to be theorised and questioned but not in the sense of a more technical or sound scientific basis. There is already massive content in the curriculum of architecture, but "in the sense of opening our use of materials, elements and details to questions of ethics, politics, philosophy, dwelling, and culture" (Ridgway, 2003, p. 161). A successful architect should know more about the technical side of design as "skilled architects tend to think in construction and detail right from the earliest sketches and often prefer to finalise all details before starting layout drawings" (Buchanan, 1989). Students of architecture must receive this knowledge right from the beginning of their education.

The table below explains the main themes described in this chapter through the structured literature survey. Main themes have been assigned, and many various sources define each theme.

Table 2: Literature Survey for the Selected Studies that Describe Main Themes by the Author.

Themes	Selected References	Main outcome points
Nature of Design and Architectural design	Alexander (1964); Dutton (1991); Farivarsadri and Alsaç (2006); Lawson (2012); Paker Kahvecioğlu (2007); Pitt (2008); Razzouk and Shute (2012); Simon (1996); Rittel and Webber (1973)	• Solving a problem; • Wicked problem • A complex activity; • A social activity; • The invention of physical objects; • Design has a playful nature in architecture; • Combination of space design and construction; • Art and science of buildings

Themes	Selected References	Main outcome points
Good Architecture	Amos Rapaport in Ching (2011); Bell (2010); Capon (1999a); Capon (1999b); Gutman (2010b); Gutman (2010a); Jackson (1995); Louis Kahn in Ching (2011); Mahmoodi (2001); Samuel Mockbee in Bell (2010); Scott (1914); Vitruvius (2006)	• Firmitas (Firmness), Utilitas (Commodity), and Venustas (Aesthetic); • Building usage, technical and social aspects; • Following nature, paying attention to construction methods and social values; • The artistic side is the core; • Sociocultural factor; • Meaning, form, context, material and construction, function, and spiritual meaning; • Solving design issues harmoniously; • Ability to change the quality of the inhabitants, their identity, and spiritual needs
Design Studio Environment	Schön (1985); Schön (1988); Doyle and Senske (2016); Eigbeonan (2013); Lawson (2005); Ledewitz (1985); Roberts (2004); Zhu (2013); Samsuddin (2008) ………………………. Bibbings et al. (2018); Ledewitz (1985); Ridgway (2003); Samsuddin (2008); Crowther (2013); Ward (1990); Buchanan (1989); Shahamat et al. (2019)	***Benefits:*** • The marriage place of art and applied sciences; • Enhances artistic and technical imagination; • Represents the practice; • Place of social learning; • Place of enjoyable learning; • Place to solve design problems; • Deep learning occurs; ***Drawbacks:*** • Resists to change and modification; • Seclusion from the outside world; • Produces narrow-minded architectural graduates; • Existing a 'hidden curriculum'; • Deprivation of built environment professionals; • Lack of integration between design and technical subjects; • Exaggerating in teaching some subjects without correlating to other subjects;

Themes	Selected References	Main outcome points
Skill Expectations from Architects	Alshuwaikhat and Abubakar (2008); Banerjee and Graaff (1996); Bell (2010); Branch (1994); Broadbent, Bunt, and Jencks (1980); Buchanan (1989); Deni and Zingale (2017); Farahat (2011); Jackson (1995); Johannes (1999); Kirkland (2012); Mahmoodi (2001); McCracken (1986); Norman (2010); Norberg-Schulz (1966); Olteanu (2017); Rapoport (2016); Ridgway (2003); Stedman (2003); Stokols (1992)	• Quality of buildings and environmental ecology; • Ability to solve problems from the environment; • Knowing designing environmental-friendly and culturally valued artefacts; • Knowing about cultural meaning in design; social and cultural well-being; material and non-material knowledge; • Practical and technical knowledge; • Understanding the meaning from the local environment; • Designers have social responsibilities; • Semiotics in architecture and environment.
General Challenges of Architecture	Branch (1994); Carlson-Reddig (1997); Cuff (2007); Gutman (2010b); Gutman (2010a); Gutman et al. (2010); H. Davis (2008); Gross and Do (1997); Norberg-Schulz (1966)	• Economy, culture, and political situation; • Professional subdivisions, such as engineers or interior designers; • Limited the authority of architect; • Rapid change of design fashion; • Increased size and complexity of buildings; • The sophistication of client organizations; • Changing expectations of architecture among the public; • Separation of intellectual and technical dimensions; • Separation of artistic and technical dimensions; • Lack of practical and intellectual abilities; • Being architecture a business.

Themes	Selected References	Main outcome points
Shortages in Architectural Education and criticism	Salama (1995); Broadbent (1988); Broadbent (1995); Chickering and Gamson (1987); H. Davis (2008); Hassanpour et al. (2013); Michael Richards (2009)	• Lack of real-life issues; • Failure in the profession; • Tensions between education and profession; • Disintegrating knowledge (lectures) and application (design studio); • Architectural education is less researched about; • Imitate the architectural work of star architects by students; • Lack of uniformity between programs and accreditation standards; • Lack of a suitable pedagogy; • Most teachers do not have a pedagogical background and education.

Through the literature survey the related researches have been condensed into less content to understand each theme and take out keywords. In the table main themes has been found and the main outcomes has been presented. The light shed on several themes, including design studio environment, shortages of architectural design, challenges, what does good architecture mean, and more specifically on the nature of architectural design. The main outcome points of the theme of nature of design have been identified, as it is a solving a problem, wicked problem, a complex activity, a social activity, the invention of physical objects, it has a playful nature in architecture, it is the combination of space design and construction, and it is an art and science of buildings. This is to know which learning theory may cope with the student-centred and suitable for acquiring the 21st -century competencies as it will be presented in chapter three.

2.5.2 Technical Courses

Architects need to consider functional, technical, and space-perception, aspects of structural systems and materials in their design (Wastiels & Wouters, 2012). They must also have skills and competencies in both artistic and scientific parts of architecture to fulfil an architectural degree (Chappell & Dunn, 2015). By its nature, architecture is the art and science of buildings and other physical structures (C. W. Moore, 1965).

Generally, architectural education curricula consist of four main categories as follow:

- Theory and history courses.
- Construction, material, and structure courses as technology-based courses.
- Technical drawing courses which are called expression-based courses.
- Design studio courses (Alakavuk, 2016; Uluoğlu, 1990).

All science-based (technology-based) courses that deal with the engineering, environmental, and technological side of architecture can be defined as technical courses in architecture. This study focuses on technical courses and technology-based courses, including structural courses, materials, and construction, building physics, and building services.

2.5.2.1 Technical Knowledge Requirements by the Architects' Accreditation Boards

Dating back to the very early periods in the first century BC, Roman architect Vitruvius described that building designers could only get qualifications when they could perform their knowledge in both practical skills and scholarly theoretical background. This assessment remained unchanged until emerging the design-oriented attitudes in the eighteen century (Whyte, 1996). There are various expectations for contemporary architects to know, one of them described by Cave (2001). As he explains, “the contemporary architect should be fluent in the use of constructional technology, the fundamental grammar and syntax of architecture” (p. 63).

Despite all the industry fragmentations and specialisation in architecture, architects must have technical knowledge in their background as an inseparable part of the architect’s professional life. Architectural accreditation boards have prepared some guidelines and musts required from architectural departments to consider in educating architectural students. It is further illustrated in Table 3. below by considering each of the ‘National Architectural Accrediting Board’ (NAAB), ‘Architects Accreditation Council of Australia’ (AACA), and the ‘Royal Institute of British Architects’ (RIBA) requirements.

Table 3: Position of Technical Knowledge Required by the Accreditation Boards, Compiled by the Author.

Accreditation bodies	**Technical Knowledge requirement**	**Level required**
NAAB	• Structural Systems • Environmental Systems • Building Envelope Systems and Assemblies • Building Materials and Assemblies • Building Service Systems • Financial Considerations	• Application of Knowledge

AACA	• Assessment and integration of construction systems and materials consistent with the project brief. • Investigation and integration of appropriate structural, construction, service, and transport systems in the project design. • Investigation and integration of appropriate material selection for the project design • Coordination and integration of appropriate environmental systems, including for thermal comfort, lighting, and acoustics • Integration of materials and components based upon an understanding of their physical properties • The nomination of quality and performance standards regarding selected materials, finishes, fittings components, and systems.	• Skill acquisition • Application of Knowledge & Skills in architectural practice • Skills acquisition • Knowledge acquisition
RIBA	• Understanding of the alternative materials, processes, and techniques that apply to architectural design and building construction; • Knowledge of the context of the architect and the construction industry, and the professional qualities needed for decision making in complex and unpredictable circumstances; and • Ability to evaluate materials, processes, and techniques that apply to complex architectural designs and building construction, and to integrate these into practicable design proposals; • Understanding of the context of the architect and the construction industry, including the architect's role in the processes of procurement and building products, and under legislation;	• Application of Knowledge

The remaining challenge of how to teach technical courses to the will-be architects should be thought to make a bridge among architectural design, professional practice, and rapid technological changes. This, for Schön (1988), is balancing between design and science together, as they have similarities and a reciprocal relationship. However, according to an experiment done by Lawson (2005) on solving a similar problem by design students and science students, they showed that they have different approaches; design students tried a solution-focused strategy, and science students used a problem-focused strategy. Based on that, it is believed that design is more than just being a science branch but has its own culture (Lawson, 2005).

Teaching technical courses needs a customized method to arrange and organize several relations because it "cannot rely on a conventional learning methodology without considering the parameters of architectural context" (Audí, Puig, & Fonseca-Escudero, 2016, p. 340). While various methods and contents are applied in architectural schools worldwide, technical courses are generally taught revolving around the previously existing methods as classroom lectures, redrawing the projects, visiting laboratories and sites, and applying information technology in some settings.

2.5.2.2 Position of Technical Courses in the Curriculum of Architecture: Top 10 Schools of Architecture as Examples

This study has also researched the availability and sorts of the technical courses in the curriculum of ten top architectural schools globally, which has been announced by QS World University Rankings by subject for 2018. As shown in Table 4, each school has had technical and science-based courses in the curriculum, yet there is a difference between the course types and the numbers.

Table 4: Technical Courses in the Top Ten Architectural Schools in the World.

Top Architecture Schools according to QS-WUR by Subject	**Technical courses**	**Notes**
MIT- Massachusetts Institute of Technology	• Environmental Technologies in Buildings • Introduction to Structural Design	
University of California, Berkeley	• Energy and Environment • Introduction to Construction	
University of Cape Town	• Technology I (major course) • Technology II (Major Course) • Environment &Services II	

Top Architecture Schools according to QS-WUR by Subject	Technical courses	Notes
	• Technology III (major course) • Environment & Services III	
Delft University of Technology	• Materialization and Construction • Construction and Climate Design • Dwelling Technology	
Harvard University	• Technology	Compulsory
National University of Singapore	• Structural Principles • The Tropical Envelope • Architectural Tectonics • Strategies for Sustainable Architecture • Environmental Systems and Construction	
University of Hong Kong	• Sustainability and the Built Environment • Introduction to Building Technology • Building Technology 1 • Building Technology 2 • Building Structures • Building Technology 3 • Building Sustainability • Making Ways and Ways of Making • Material Fabrications • Building Technology 4 (Building Construction and Practice) • Building Technology 5 • Building Integration • Building Structures and Systems	• Both compulsory and Electives
The University of Melbourne	• Construction as Alchemy • Construction Analysis • Construction Design	• Compulsory •
The Bartlett School of Architecture	• Structures, Materials and Forming Techniques • Design Technology	• Compulsory
University of New South Wales	• Architectural Science and Technology	• Compulsory

Top Architecture Schools according to QS-WUR by Subject	Technical courses	Notes
	• Architectural Construction and Structures	

As shown in the table above, in the top 10 architecture schools' curriculum, technical courses are provided. The need to have this knowledge in the education of the prospective architects is underscored. Some schools, the University of Hong Kong, for instance, put a bunch of the technical courses into the curriculum, both as compulsories and electives. While some other schools as Harvard University, introduced technology as a general term to refer to the technical courses. Subjects introduced under technical courses in these universities, which are geographically different, are diverse. This may be because of these countries' specific characteristics, from environmental factors, market needs, and cultural backgrounds, to name a few.

2.5.2.3 Importance of Technical Courses in Design Education

Theoretically, no design can house its purpose without the technical side of it. Otherwise, it may remain merely as a piece of art that embraces no human accommodation. So, in design education, it is necessary to underscore this vital side. There is no doubt that an architect with no or less technical knowledge cannot be a designer who can persist on his/her design ideas, but oppositely he/she should leave the design for other professionals in technical knowledge to solve the issues for him/her. In this case, the architect might not be a good player in the field nor the teams.

Below, the types of technical courses taught in architectural schools are explained to know how important the position they have in the design is:

Structural courses: these courses introduce students to the subject of designing structures for their design projects. Historically, architects were responsible for the structural design of the artefacts they designed. For instance, when a dome was designed, it was for a structural purpose and influenced all the sides of the space design. The main challenge of architects was/is how to enforce the buildings to resist gravity, lateral loads from winds and earthquakes, and other environmental forces. They have thought of a suitable structure according to the building types, topography, and environmental considerations.

The relation of structure and space in architecture is not a static relationship. Sometimes the structure itself is the space creator without any other medium, as in igloos (Azizi & Torabi, 2015). So, thinking of structure in such a physical artefact is the whole thing.

Structural knowledge does not stay on only the building skeleton proposition. When designers design a structure, they do calculations, drawings, specifications, materials, and costs. The structure's subject has become a separate discipline, and the structural knowledge gained a complex domain. Having this knowledge lost its significance in the profession of architecture, but it has a vital role in architects' profession and education (Sandaker, Eggen, & Cruvellier, 2013).

Today, there is structural engineering as an independent profession, yet, it has not deprived architect of structural knowledge because "architects suggest an idea for the structural system based on experience from 'similar' design projects and designate the preferred locations and approximate dimensions of the structural system members on the architectural plans" (Yazici & Yazici, 2013).

Materials and construction courses: these courses deal with the vital role of constructing buildings and materials. In these courses, the focus maintains on probing connections and properties of materials and the intrinsic relation of these materials with structural systems and environmental performance.

Throughout learning from this course, students are expected to form a thorough understanding of construction and constructional systems. There also an emphasis stays on strength of materials and their components. Furthermore, students may understand how best they can choose suitable materials for their design and how choosing these materials can affect their design concepts. This decision to choose building materials is related to durability, economy, and aesthetics. That is why students need to digest the knowledge that is delivered in this course for the sake of a better-considered design.

These courses' content can be different from an institute to another, yet, in all of them, the aim is to familiarize students with the factors of material selection and materializing design concepts from foundations until final finishing layers of buildings. Students also familiarize themselves with essential issues related to the materials' technology and sustainability considerations (Lauren Lynn, Berrydoris, Sung, & Nulman, 2019).

Building physics courses: the main aim of building physics in architecture is to arm the students with knowledge of climate and environmental considerations. These courses deal with both indoor and outdoor climate and the concerns of energy use in buildings. Subjects as heat transfer, moisture issues, acoustics, and lighting are all to be studied.

This subject has a great importance in architecture, and they affect other sides of the design from the material selection and economic concerns. Buildings are designed to give protection and comfort to humans, both physiologically and psychologically. These courses aim to provide knowledge on these issues, and without considering this, the design remains not quite efficient for its role. These courses can be differently delivered from place to place as the climate and environmental solutions are different in different geographical locations. As mentioned previously, this course's knowledge helps architects deal with human comfort in indoor spaces.

Building services courses: the content of these courses can be very intricately related to mechanics as they deal with heating, ventilating, and air conditioning systems (HVAC) and other related subjects. Like building physics' courses, these technical courses emphasize the environmental aspects' control to provide indoor spaces with an atmosphere more appropriate to human life. The knowledge supplied is mostly about the mechanical aspects, such as methods, instruments, and tools of heating, cooling, and ventilation. Contemporary methods are illustrated, and calculations are introduced, and installation techniques and maintenance methods are presented. These courses' focus can be broad to renewable energy methods of solar panels and fire system controls, sanitary systems, hot water distribution systems, pipe distribution, electric systems, electrical stairs and lifts, smoke control, water drainage, and identify types of these subjects.

By completing the course, students are expected to imagine the provision of these systems and considerations to make the design better accommodate functional needs. Students also understand the need for space requirements and adequate space allocation for these systems when they design. In case of not having enough knowledge in this area, architect "has confronted the realities of making buildings work and providing the services to do so" (Luther, 2006, p. 279).

2.5.2.4 Existing Methods and Tools of Teaching/Learning Technical Courses in Architectural Education

The concepts of design education and learning in architecture are to realize architects' abstract ideas in the world of physical forms. Continuously, giving the qualities that enable users, skilled workers, and clients to comprehend the designer's thoughts. Thus, schools of architecture emphasize teaching/learning the technical knowledge that can elaborate on what is necessary to actualize a design concept to a physical entity. These schools attempt to deliver technical courses in various ways, methods, tools, and strategies. The following are several methods, approaches and strategies used currently in teaching/learning technical courses in architecture schools above and other schools around the world, based on the literature surveyed. Methods are divided as technology-oriented methods and life projects, shown below:

Technology-Oriented Methods

Integration of BIM Programs: Today much different software is used to boost the construction and technical knowledge, especially the BIM (Building Information Modelling) based programs that have digital intelligence. This software can offer a wide range of expertise in construction details, realistic renderings, time management schedules, and calculations. One of the endeavours for the inclusion of ideCAD, is an example of a BIM-based software, to the design studio was by Alakavuk (2016) to the course 'Integral Design Studio III' in the architecture department at Yasar University in Turkey. In this class, which was initiated in 2013, she required the students to consider earthquakes' effect on residential units using ideCAD software. The structural members were tested by ideCAD that showed the results allowed the students to see whether what they thought during design was logical or not. It had let the students examine the logic behind members' dimensions, technical explanations, and the content ratio of materials in these members, for instance, steel ratio in beams and columns.

Using Laboratories: Laboratories are known as places for conducting experiments in the field of science. Laboratories in educational fields, including architecture education, provides students to learn by experience; learning by doing. Technical knowledge, in the same ways, can be learned and taught in laboratories, i.e., students can be involved in experimenting and touching building materials. They may also see and make physical entities related to structures and architectural elements that may enrich their technical knowledge. Laboratories can have several types; Elawady and Tolba (2011), divide laboratories into three types: Hands-on labs, simulated labs, and Remote Labs. They describe these Labs as:

1) Hands-on Labs are those where real-life experiments are conducted. Each information or examination is gotten through physically set up preparation.
2) Simulated Labs referred to computer-based processes, doing imitations for real-life cases through simulations, with less time and lower costs.
3) Remote Labs are computer-mediated Labs; they look like hands-on Labs in terms of space needs and having real-Lab necessities. The only difference is the distance between the experiment and experimenter, which controlled by computers.

The three Labs mentioned above can be used connectively or separately in architectural education. Ma and Nickerson (2006) and Elawady and Tolba (2011) conducted studies on the comparison of these Labs. Their result appeared that hands-on Labs are more successful than other sorts of Labs.

Hands-on Laboratory types: the concept of hands-on laboratory refers to a range of laboratories operated by certain universities and institutions. For instance, in Meijo University in Japan, the section of laboratories has been opened under the department of architecture. This department includes five different laboratories, which are:

a) Design and planning laboratories: in this branch, human life-related subjects are dealt with by specialists, such as human behaviour, social topics, ideal architectural spaces, and building stages.
b) Environmental laboratory: this branch pays attention to scientific subjects researching and estimating noise coming from the environment on the urban level. Heating, cooling, and ventilation issues are examined. Acoustic materials and application methods to investigate sound effects from outside and inside and their influence on the human body and psychology are also paid attention to. Another subject of this Lab is evaluating solar energy in buildings.
c) Structural laboratory: this Lab is specified for safety issues in buildings and structures, to keep the balance between aesthetics and rationality and between form and function at the time.
d) Materials and Construction Laboratory: Clear by its name that this branch is dedicated to properties of building materials and methods of construction.
e) Lab of History and Design: in this Lab, researching the history and learning from it is specified, such as restoration and conservation techniques from history. This Lab is also studying design, especially in Japan and other Asian countries with a critical eye and thoughts (Design, 2014).

Virtual Laboratories

Changes in technological developments have made the World Wide Web a dispensable part of education. Virtual laboratories are the outcome of WWW that played a big part in teaching and learning organizations. These Virtual Labs in some countries have replaced the real hands-on Labs. They are grounded in Mathematical Representations, Webs, Multimedia Technologies, and Computer Simulations. Application of Virtual Labs has lower costs, safer, more efficient, and better than hands-on Labs. Resources and reports can be shared among organizations easily. Another advantage is that they can be useful for the distance learning model (Li, 2015).

Indian Ministry of Human Resource Development (MHRD), as an example, has systematized a Web-based Virtual Laboratory among 12 universities in the country. It allows these universities to use the same system and share their resources. It is highly preferred in the country for the sake of cost minimization and obtaining the updated information. The Indian government, through the MHRD, has confirmed the main purposes of these Labs as such:

a) Remote-access provision is not just for the architecture or engineering fields, but for various disciplines from undergraduate studies to the higher stages and on.
b) Encouraging students to experiments from various levels, easy to advanced levels, in these Virtual online Labs without distance barriers.
c) To develop a comprehensive Learning Management System for Virtual Labs, students have access to resources, video tutorials, animations, and self-assessment tools, including various learning tools (B. Kim, Park, & Baek, 2009).

Live Projects

The live project method is defined as "a type of design project distinct from a typical studio project in its engagement of real clients or users, in real-time settings. Students are taken out of the studio setting and repositioned in the 'real-world'" (Sara, 2006, p. 1). This method requires the students to involve in the real projects outside of the design studio and design tutors, but rather collaborate with the actual clients and existing building problems (Chiles & Till, 2004). According to a survey in the UK, half of the architectural schools in this country are applying this method (Sara, 2004). However, this method has made many controversies among thinkers, whether it can be considered as an architectural education pedagogy, or is it even an architecture-related subject or not (Harriss & Widder, 2014). The live project faces the challenge of bridging the gap with the design studio projects and the semester time limits for the students. One of the other limits in the Live Project is money, as students need to travel and work for clients for free. Other factors, such as safety and time management, are also restraining it from working seamlessly (Chiles & Till, 2004).

Design-Build Method: Design-build is one of the "hands-on approaches to pedagogy in the form of full-scale construction exercises they have emerged in schools" (Erdman et al., 2002, p. 174). However, there is a misconception by the building industry for the 'design-build' expression; it is understood as a project delivery process (Corser & Gore, 2009) in the building industry market. However, here, it is presented as a method that is applied to deliver technical knowledge by some schools of architecture.

Gaber (2014) emphasizes on the need for design-build (learning by making) within the initial stages of architecture study. In his effort to incorporate design-build into the curriculum, he enquired the students to create real size models for their designs, with the thoughts for social, budget, time, needs, commercialization concerns, and locally available materials from the setting chosen for their designs. Students are required to make smaller-scale models such as 1:10 for the appraisal stage during the semester and as teamwork. After the evaluations and appraisal, then they do the construction 1:1 scale model with local construction materials.

2.5.2.5 Summer Practice

Some architectural departments worldwide are commonly incorporating summer practices in their curricula through their specific and different methods for the same purpose. Some of these universities seem to be satisfied with the results of these summer practices in raising students' awareness of technical knowledge. In this process, visits are arranged to the construction sites, and students have the chance to observe, ask, and involve in the real construction details and issues. These practices are required as a partial requirement for students' graduation by some universities. Some other universities require students to work in architectural offices during the summer holiday to learn what is going on in the real practice by design offices.

2.5.2.6 Contemporary Learning Tools Applied in Teaching/Learning Technical Courses

Virtual Reality

Alvarado and Maver (1999) define virtual reality as a computer technology for 3D simulations, and it has application in architectural work that helps to visualize the design and conceptual construction methods before construction on-site. This technology can provide students with a 1:1 virtual environment to enter and experience the required knowledge like reality. Due to high technological sophistication, students experience a 'sense of presence' (Messner, Yerrapathruni, Baratta, & Whisker, 2016).

Through these simulated 3D settings, students can better understand the plans and construction systems. Nowadays, because of rapid technological changes, changeable results in these high graphical surfaces are produced by computers. It gives learners a real place by putting them into these micro-spaces and having this opportunity to test 3D entities with real-life sizes (Messner et al., 2016). Thus, virtual reality can simplify the hard effort we need in experiencing outside. This gives students and professional skills to design in digital spaces without losing a sense of materiality, gravity, and structure (Gines, 2015). Virtual reality can be useful in various fields related to architecture education; from many stages and different domains.

Virtual Reality, according to Alvarado and Maver (1999), can be applied in a variety of subjects from basic courses to advanced ones:

a) Theory and History; in reviewing the historical and schematic cases through modelling.
b) Technical courses; in modelling structures, construction details, and systems, visualising building services, etc.
c) Design Studios; in modelling students' proposals, reviewing examples of contemporary architecture, etcetera.

2.6 Chapter Summary

Overall, based on the literature survey regarding the architect's role throughout the time, architectural design, architecture education, and its profession, technical knowledge is indispensable. Because technical knowledge can potentially affect the professional life of the architect and the logic of design concepts, without it, architects may lack a significant section of the profession, which is to actualize/materialize their designs. To the part of the literature survey, which is seeking for the technical knowledge required by the architectural accreditation boards, three prominent architectural accreditation boards has been taken into consideration. The outcome showed that technical knowledge is one of the must subjects to have in the education of these schools that are accredited by these boards. To incorporate this knowledge, schools of architecture have tried several methods, strategies, and tools. However, these attempts seem not to have an appropriate pedagogical base. That is why technical courses are not perceived as an important integral part of their design projects by architecture students.

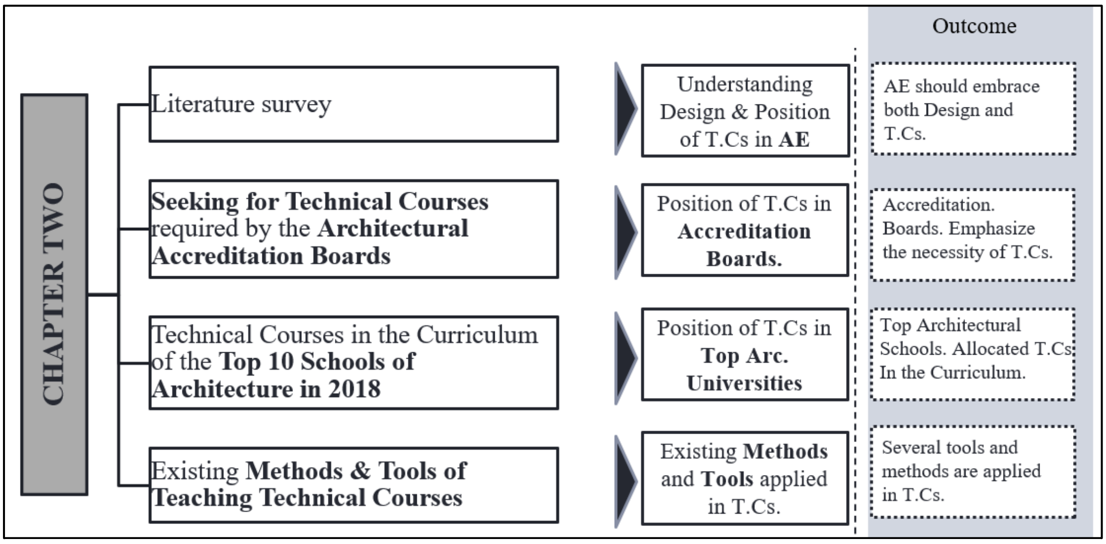

Figure 9: Summary of Chapter Two

Chapter 3

PEDAGOGIES AND LEARNING THEORIES

3.1 Introduction

This chapter deals with the teaching/learning theories and 21st-century competencies as a major concern of this research, to understand which pedagogical approaches can help students to be armed with necessary competencies to cope with the rapid developments in technology. Some researchers believe that educational mediums should consider adapting their curriculum to the 21st-century competencies to keep the graduates armed with adequate skills and competencies required by today's market. At the same time it has been tried to find whether there are teaching/learning theories which support the studio based design education as it is the core of architectural education. This is to discover whether the educational approach used in design education can be beneficial in teaching/learning technical courses as well. For this reason, the research initiates with the notion of learning, learning in the 21st-century and continues with a discussion on various learning theories/pedagogical methods.

Dictionary.com defines education as "the act or process of imparting or acquiring particular knowledge or skills, as for a profession". Initially, the word education is derived from the Latin word 'Educare' which refers to 'bring up' and 'raise' (Bass & Good, 2004). Furthermore, according to some resources, the history of formal education dates back to the ninth century BC (Lawton & Gordon, 2002).

Lawton and Gordon (2002) report that “[e]ducation may be said to start to exist when some teachers cease to accept traditional beliefs automatically and begin to ask ‘why?’” (p. 10). Like many other human needs, education always needs updating to make it more beneficial and thriving as a process.

Human beings thought of different ways to deliver what they knew to the next generation or others through the time being. So, learning, which is “an internalization process that depends on individual components” (Yurtsever & Polatoğlu, 2018), has a long history. It is as old as human life on this planet. Throughout this history, many learning theories are introduced. Some theories emphasized human behaviours, some of them on mind and cognition and the social dimensions of the learners. The Dutch Humanist and educator Erasmus (1466-1536) believed that the learners should enjoy what would be taught. At this point, teachers should have enough knowledge about how to make subjects interesting to different individual backgrounds (Lawton & Gordon, 2002) in a way that motivates learners to follow enjoyably. This coincides with what is called a student-centred approach, whom students have a central role in the process of learning, and have the right to question what they learn and have a voice in decision making for what they learn. In this way, learners keep up to date and acquire the necessary skills for the contemporary era.

3.2 21st Century Competencies

Terminologies interrelated to 21st-century competencies are everywhere. Every institute, university, profession, etcetera. try to discuss and correlate what they do or teach to 21st-century skills requirements. What makes the 21st century different from our current or past time seems to be the expectations towards coping with a more fast-paced world. When we talk about competency, it has a broader boundary than skills or knowledge (Rychen & Salganik, 2003). Competence or competency can be defined as the capacity to apply what is learned sufficiently. In a defined context, "[a] competence is not limited to cognitive elements (involving the use of theory, concepts or tacit knowledge); it also encompasses functional aspects (involving technical skills) as well as interpersonal attributes (e.g., social or organizational skills) and ethical values" (Ananiadou & Claro, 2009, p. 8). Finegold and Notabartolo (2010) grouped 21st-century competencies into five groups, as shown in Table 5 below:

Table 5: 21st Century Competencies Grouped by Finegold and Notabartolo (2010).

Analytic skills	**Interpersonal skills**	**Ability to execute**	**Information processing**	**Capacity for change**
Critical thinking	Communication	Initiative and self-direction	Information literacy	Creativity / innovation
Problem-solving	Collaboration	Productivity	Media literacy	Adaptive learning / learning to learn
Decision making	Leadership and responsibility		Digital citizenship	Flexibility
Research and inquiry			ICT operations and concepts	

What is vital for architecture and architectural education is considering the 21st-century competencies, too. Some accreditation boards such as the Royal Institutes of British Architects (RIBA) and the Royal Australian Institute of Architects (RAIA) far already mentioned the 21st-century requirements and incorporated them into architectural education. Wallis (2005) compares the RIBA's *Architectural Education for the 21st Century*, The RAIA's *Education Policy* and the *Boyer Report* (*A New Future for Architecture Education and Practice*—published in 1996 and commonly called "the Boyer Report"), and identifies six common themes to have in architectural education for the 21st century which are:

a) Diversity;
b) Teamwork;
c) The relationship between education and practice;
d) Design and creative problem-solving skills;
e) International recognition of qualifications; and
f) The justifications of established professional roles (Wallis, 2005).

These themes are also demanding in having a student-centred and life-long learning approach in architectural education, in both design and technical courses. To do so, the study delves into relevant teaching and learning theories to know which teaching/learning theory has relevancy to be applied in teaching/learning technical courses in architectural education.

3.3 Teaching and Learning Theories

Learning by nature, is considered to be an internal process and different from one person to another. It is a change that leads to gain new knowledge through cognition, which covers problem-solving, thinking, perception, reasoning, and remembering (Samsuddin, 2008). Psychologists discuss learning as “relatively permanent changes in an organism’s behaviour that occur due to an experience in gaining new knowledge or skills” (Lindgren, 1971).

Learning is a complex process, and there are multiple types of learning methods. Thus, a single ample method of learning does not exist (E. Phillips, 1982). Psychologists’ endeavours have suggested/developed various learning theories, which eventually has been divided into several groups. Some of them focused on the environmental stimuli and their impacts on starting learning; others studied the cognitive process, while another latter group was interested in the influence of social aspects on the learning process (Samsuddin, 2008). For this study, and to highlight the learning process's significance, the following theories: behaviourist theory, cognitive theory, constructivist theory, and social learning theory, as the most principal theories in education, will be discussed below.

3.3.1 Behaviourist Theory

This psychological learning theory deals with native language learning and reactions towards grammar founded by John B. Watson (Demirezen, 1988) in 1913. According to this theory, the human mind is more like an 'empty box'; learning happens when the mind is filled with new information from human interactions to the environmental stimuli. Metaphorically, the mind functions like a machine, which needs programming, and this theory considers human beings as inactive learners (Pope & Keen, 1981). To reinforce this condition and to let the learning process happen, behaviourist theorists propose 'conditioning' and 'reinforcement' principles; 'rewarding' as an example (Wenger, 2009).

For behaviourist theory, the model of the student as a 'recipient' and teacher as a master or 'knowledge provider' has an explicit nature, where the knowledge is gathered outside of the mind, then it is being internalised by the learner through explicit instructions (Jarvis, Holford, & Griffin, 2003). "Therefore, this approach is repetitive, objective and mainly concerned with the search for a single, absolute truth" (Samsuddin, 2008, p. 10). In this model, students are entirely dependent on their teachers, and instructors aim to provide knowledge. The process considers all the learners as equal, and the learning method is similar for all. The learning process starts from simple to more complicated later on, and reinforcements will measure the overall performance as grades, praises, and incentives alike (Hertel & Millis, 2002; Wenger, 2009). The experiments on this model showed that this method is effective gaining basic knowledge of literacy, numeracy, and physical subjects such as writing, etcetera.

This method for transferring knowledge mostly depends on the visuals and mechanical procedures of the target knowledge until all the knowledge assimilates to the learners' minds (Nelson, Benner, & Mooney, 2013). The drawback in this theory is "it neglects the importance of the learner's internal mental activities that involve thinking and reasoning processes. Such processes create and modify the mental structure that allows learners to interpret, organize, store and retrieve information " (Samsuddin, 2008, p. 10).

3.3.2 Cognitivist Theory

In cognitivism, learning is viewed as a process similar to the computer inputs process as the received information first is saved in the short memory and encoded for long-term memory (Siemens, 2004). In contrast to behaviourist theory, in cognitivist theory, human beings are considered active learners with an innate capacity to learn new information without interaction with environmental provocations. For this theory, what happens to learners has no significance, but rather what they achieve or do is interested. Constructing 'mental maps', which includes organized wholes and meaningful patterns, is in the focus of the studies related to this theory (D. C. Phillips & Soltis, 1998). Here, the relationship between teacher and students is in the form of 'give and take', which is not mechanical opposite to what is seen in the behaviourist theory. This relation leads to an active interaction between the two; teachers guide students to make meaningful configurations to solve problems and ambiguous issues (Hergenhahn & Olson, 2005). In this situation, teachers transform their teaching materials into meaningful concepts and units, which hold the holistic notion of the experience or the overall concept.

This process can let students retrieve whatever they need easily and effortlessly, which is previously saved in long-term memory through these important links (Lindgren & Suter, 1985). Cognitivist theorists refrain from supporting any kind of memorising information and following some predetermined rules without understanding them; they believe it potentially encourages making mistakes. The acquired information or knowledge is insightful and unforgettable because it comes from solving problems and discoveries (Samsuddin, 2008).

3.3.3 Social Learning Theory

Through observation, imitation, and modelling, human beings can learn through the socialisation process and imitating each other (Bandura, 1962). Bandura represented this phenomenon as 'social learning' or 'observational learning' as an indication of the learning process due to cognition and observation resulting from continuous interaction (Bandura & Walters, 1977). This theory perceives human behaviour as a reciprocal interaction among environmental, cognitive, and behavioural influences. Modelling, which is the last stage in learning here, needs four necessary conditions to be formed perfectly, which are: attention, retention, reproduction, and motivation.

According to Bandura (1969), various factors affect attention level, increasing, or decreasing, like functional values, complexity, prevalence, etcetera. Moreover, individuals' personal characteristics are also useful, such as past reinforcement, sensory abilities, arousal level, etcetera. Then, retention is required, which is meant by recalling what you took care of. Such as "symbolic coding, mental images, cognitive organization, symbolic rehearsal, motor rehearsal" (David, 2019). Later, reproduction that refers to image reproduction includes physical and self-observation capacities.

Latter is motivation, which requires learners to have a good reason to be motivated, such as incentives, past, and seeing the strengthened model.

At first, in this model, learning is mainly viewed as an individual sensation; the learner is the sole inquirer of knowledge (D. C. Phillips & Soltis, 1998). Bandura viewed "personality as an interaction between three components: the environment, behaviour, and one's psychological processes (one's ability to entertain images in minds and language)" (David, 2019). Nevertheless, this perspective had overlooked the fact that learners also belong to social groups. Learners come from families with parents, siblings, friends, teachers, and peers. They are already a part of a reality, who communicate and interact with others; because of receiving stimulation and guidance. This type of knowledge accumulation is called 'social learning'. The example of this kind of learning can be seen in history, science, literature bodies of knowledge as these knowledge construed by writers, scientists and researchers is the result of social interactions, negotiations, relationships, and demonstrations (D. C. Phillips & Soltis, 1998).

The recommendation from this learning model is that learners have to improve their skills, problem-solving strategies, and performances through criticism and self-evaluation based on these role models they might have (Hergenhahn & Olson, 2015). According to social learning theory, students can learn better and more quickly when interacting and working in groups with other peers (Fosnot & Perry, 1996). That is why Samsuddin (2008) believes that learners thinking is concerned with:

> talking with others (peers, tutors or experts), moving around, manipulating apparatus, mumbling, looking for other references and so on. The occurrence of learning is more effective and natural in 'situations' where the students are located and actively engaged with people, events within those 'situations'. (p. 14).

Finally, Lazarevska (2019) points out to several learning advantages of social learning theory, which are:

- Enhancing engagement for disengaged learners;
- Development of self-organisation skills;
- Improvement of collaboration;
- Expanding workforce-related skills.

Observing the advantages of the social learning theory, it can be said that the design studio is a unique example of social learning theory, where students construct their knowledge through collaborations and engagements in group works.

3.3.4 Constructivist Theory

Hein (1991) defines constructivism as a term, which "refers to the idea that learners construct knowledge for themselves---each learner individually (and socially) constructs meaning---as he or she learns" (p. 1). Moreover, learning is just about constructing meaning and interacting with people to their surroundings to understand and making sense of it through their perceptions and nothing else (Berger & Luckmann, 1991; McMahon, 1997; Vygotsky, 1978).

Constructivism is a broad subject with many facets, such as trivial, social, cultural, feminist, critical, and radical constructivism (Haryadi, Iskandar, & Nofriansyah, 2016). Furthermore, it is considered an umbrella for different theories and loosely connected concepts and has dominated education for many years (Engström, 2014). Constructivist philosophy is well-known for its major applications at different levels of education (Gash, 2014). "All constructivist approaches, therefore, share the intricate problem of the relationship between observer and world – or system and environment" (Alrøe & Noe, 2012). According to constructivism, knowledge cannot be transferred from one mind to another, but it can be ‘constructed’ through learners’ interaction with the world of things (Hendry, Frommer, & Walker, 1999). According to J Piaget (1954) and von Glasersfeld (1989), the focus of constructivist approaches to education is on what is going on in the learner’s mind, rather than the outcome in the form of a product.

Duit (2016) reported that constructivism had become a new ideology for teaching/learning scientific subjects for some educators. In radical constructivist terms, learning can be imagined as an ongoing conversation held between the learner and the world she/he is trying to understand (Herr, 2014). With this approach, learners experience learning as accommodation through modifications of their prior knowledge when interacting with the milieu (von Glasersfeld, 1995). This concept is familiar to design education; when seeking ‘what works’ in design, radical constructivism is explicitly practiced in this context (Herr, 2014).

When it comes to technical knowledge and construction, it is construed as a complex cyclic system. Especially after “[t]he new techniques developed in the last century and the general mechanisation of production facilities led to sub-theories concerned with the achievement of forms” (Pask, 1969). It has made the technicality of design and realising it as a physical artefact even more difficult.

To know what is cybernetics, both first-order and second-order cybernetics will be explained below. Cybernetics (first-order cybernetics) can be defined as “the science of control and communication, in the animal and the machine” (Wiener, 2019) in terms of having a cyclic process. Thus, cybernetics is a ‘theory of machine’, yet, it does not question the world of things but how to behave; ‘what does it do?’. Cybernetics has become the focus of many people in biological sciences, sociology, and psychology to apply its methods and technics in their specialty (Ashby, 1961). Because it can observe systemized organizations and “it connects control with communication” (Pangaro, 2013). It is called “systems that embody goals” (Solomon, 2007). When it comes to knowing whether we have approached the goal, cybernetics require ‘feedback’. In the field of education, cybernetics is mostly known as ‘applied epistemology’ (Pangaro, 2013). So, cybernetics is all about a cyclic process from starting, to feedback and so on. This core of this process is to control the learning process. The controlling factor in the educational process is the teacher, and the managed system is his pupil (s). The teacher's challenge is to motivate his students by specific knowledge and to instil in them a pattern of actions that will result in the development of attributes that correspond to the given target. This power is wielded as part of a strategy or initiative. External factors influence both the teacher and the students (the outside world). A steady flow of knowledge on the effects of the teacher's control, i.e. feedback, is needed for performance (Landa, 1977).

Second-order cybernetics is a newer version of cybernetics (first-order cybernetics discussed above), also called ‘cybernetics of cybernetics’ while the difference is, “second order cybernetics presents a new paradigm; in which the observer is circularly (and intimately) involved with/connected to the observed” (Parra-Luna, 2009, p. 60). So, second-order cybernetics values the contribution of the observer to the observed even sees it as inseparable. Furthermore, second-order cybernetics “is seen as connected to the philosophical position of constructivism” (Parra-Luna, 2009, p. 59). That is why when it comes to interconnection/application of second-order cybernetics in education it is the same as radical constructivism; they are like the opposite sides of the same coin (Glanville, 2012).

Considering the characteristics of design and constructivism, Glanville (2012) connected design to radical constructivism by exemplifying design as the cognitive act's origin. In design, the way concepts are formed are combined, and this organizes the understanding of it (Glanville, 2012). Understanding this formation, which is a principal act of design, requires a dialogical and circular process (Schön, 1985). This cyclical process of the design means it has a strong relationship with cybernetics (Pask, 1969). Moreover, "developments in design and cybernetics share yet more parallels, including their adoption, and eventual rejection of, the technical-rationalist approach" (Herr, 2019, p. 155). Constructivism is also an ideal ideology for some educators to deal with teaching/learning problems in science education (Duit, 2016). An education grounded in constructivism provides opportunities for learners to engage in situations that promote or in which they can construct their understanding (Herr, 2014).

For radical constructivism and second-order cybernetics, architectural design education generally entails more than mere linear problem solving; instead, it has a conversational structure that allows designers to immerse themselves and create successful designs in complex situations (Gedenryd, 1998), as in the design studio. The design's conversational aspect is revealed by emphasizing the vital connection of design and cybernetics (constructivism) (Jonas, 2012; Pask, 1969). The nature of construction and technical subjects in architecture matches the cyclic process described in radical constructivism. Through this analogy, the application of radical constructivism (both cybernetics and second-order cybernetics) is a viable option for teaching/learning technical courses.

With this method, students experience deep learning through an enjoyable process.

Like cognitivist theory, constructivist theory assures meaningful learning and experience because of the learner’s active learning processes. What is different is they perceive learning as a progressive ordered process and having several sequences, unlike the cognitivist, who believe in learning more like an intuitive and direct process, free of clashes and as a total discovery (Pope & Keen, 1981). According to this model, learners should experience developmental growth to fulfil learning. According to an experiment by a developmentalist and biologist, Piaget, older children, due to their maturity, can better understand their surroundings than younger ones, that is why they can learn faster and better (Samsuddin, 2008). It coincides with John Dewey’s ‘learning from experience’ as, through progressive thinking, human beings are seen as ‘inquiring organisms’ (D. C. Phillips & Soltis, 1998).

Learning occurs through solving problems, which leads to organizing and reorganizing the learners' current knowledge and enhancing the ability of problem-solving after all (Lindgren & Suter, 1985). This process provides learners route, structure, and evaluation; that is why it makes learners mature enough to collect a meaningful experience through actually doing and interacting (Fosnot & Perry, 1996). Piaget believes that both the environment and human beings are in a changing process. For instance, a baby does not interact with surroundings at first until development occurs and starts to interact and touch the objects around. In contrast, an adult, because of his/her maturity, develops a schema that can deal with abstract ideas related to the environment. That was the same child as he/she undergone many sequential alternations until he received this maturity (Hergenhahn & Olson, 2005).

Delving into the theories of learning and pedagogical methods can provide us with a clearer vision for recognizing architectural education in these theories. Then it may help us with what this study intends to propose for teaching/learning technical courses in architectural education.

In the constructivism approach, teachers or tutors act as guides and advisors to assist learners in completing their self-schema. It is possible through preparing learning materials and proposing the subjects to be learned in form of a problem gives the learners a challenge to solve future problems, too. However, it should be organized to let the learners apply their familiar ideas before heading to solving the issues required. Furthermore, students need more support from the educational milieus to develop problem-solving skills and construct meaningful learning activities. Interaction with their peers provides learners with more opportunities to learn better. The main goal, which is meaningful learning, can be achieved by developing and interpreting new thoughts rather than the subject matters from textbooks delivered by teachers (Pope & Keen, 1981).

In the study *Radical Constructivist Structural Design Education for Large Cohorts of Chinese Learners*, Herr (2014) applied radical constructivism and second-order cybernetics to develop a learning/teaching method for the Structure and Materials module, a compulsory course in the BEng (Architecture) at Xi'an Jiaotong-Liverpool University in Suzhou, China. Her model was applied to a 200-student class with various teaching strategies to engage learners with the subject of structures individually. "Modes of learning and teaching employed include[d]: an emphasis on case studies and rich imagery in lectures, teamwork, experimental model building, drawing-based in-class and homework exercises, construction site visits and offering a closer dialogue between students and teacher via social networks" (Herr, 2014, p. 395).

Table 6: Comparison of Learning Theories, Adapted from (Entwistle, 2003).

Themes	**Behaviourism**	**Cognitivism**	**Constructivism**	**Social learning**
Best for teaching	Task-based learning involving lower-order thinking skills, such as remembering, understanding, and applying.	Problem-solving involving higher-order thinking skills, such as understanding, applying, analysing, evaluating, and creating.	Solving ill-defined problems involving higher-order thinking skills, such as understanding, applying, analysing, evaluating, and creating.	Observation, imitation, and modelling Modelling: obeying SL principles; Attention, retention, reproduction, motivation.
Role of the instructor	Present learners with structured material (stimulus) and prompt for the right response.	It provides learners with strategies that allow them to connect new knowledge to existing knowledge.	Aids learners in exploring topics and coming to their understanding by asking questions.	Providing a collaborative learning environment, combining ‘formal learning’ to the community.
Role of the learner	A blank slate, a passive participant to stimulus-response.	An active participant, engaged in transforming, rehearsing, storing, and retrieving information.	An active participant, building interpretations of the world based on individual experience.	Linking new knowledge to a specific subject to receiving motivation and modelling after all.
How does learning occur	When learners can transfer stimulus-response to more general and new situations.	When learners retrieve information and apply it in a new or different situation.	When learners use their knowledge in a real-world situation.	When learners motivate to watch someone else’s work and be rewarded.

The above table illustrates the comparison between the theories of learning that mentioned in this research:

In the table above, both cognitivism and constructivism are more towards teaching/learning through problem-based learning. While with some nuance differences, constructivism emphasizes exposing ill-defined problems, which even adopts more self-directed learning. In solving ill-defined problems, students take control of their problems and identify them rather than their instructors. In social learning theory, the focus is on the social side of learning from each other by observing and imitating. Moreover, in behaviourism, learning is based on task provisions, which can be learned through memorising without more thinking involvement. The instructor's role in all the theories, except behaviourism, is an organizer and facilitator. In cognitivism, the instructor provides students strategies to approach the problem unlike constructivism, who instructor aids students in the major-undetailed topics letting students think on adapting their own methods. In social learning, the instructor focuses on making a collaborative learning environment. However, in behaviourism teacher is looking for the right answer from the material provided. In the three theories of cognitivism, constructivism, and social learning, learners are actively and motivated enough involved in the learning process. Still, in behaviourism, students are passive learners and expected to give back the knowledge the same as they got without changes. Learning occurs when learners transfer the knowledge to new situations, while in cognitivism, they retrieve what they have learned and apply to a new situation. In cognitivism, learning happens when learners use their knowledge in a real-life environment, and in social learning, students learn from each other’s work through collaborations and imitation.

One of the strategies of Herr’s work was problem-based learning (PBL), which “is an instructional method that is said to provide students with knowledge suitable for problem solving" (Schmidt, 1983, p. 11). Its origin is medical sciences, then architecture cultivated similar approaches in its education after Donald Schon's writings on the reflective practitioner, as this is accepted as one of the teaching strategies of constructivism (Hendry et al., 1999).

3.3.4.1 Problem Based Learning (PBL)

Both constructivism and cognitivism theories adopt PBL in the educational medium. Learning through PBL is considered life-long and unforgettable due to involving learners in problem finding and solving. Before passing to PBL, it is necessary to define 'problem' as a term. The Cambridge English Dictionary defines the problem as "a situation, person, or thing that needs attention and needs to be dealt with or solved". Furthermore, the Web of Definitions & Translations also outlines the problem as:

> …the relation between human will and reality. When will and reality do not coincide, the resolution of this gap between reality and will is the solution of the problem. A problem implies a desired outcome coupled with an apparent deficiency, doubt or inconsistency that prevents the outcome from taking place.

From both definitions, 'problem' requires human efforts to elevate the current situation into a desired one. This situation can be anything, yet the critical thing is that it demands contemplating and thinking, comparing, and seeking better alternatives. The idea of this approach came from the massive studying materials of the school of medicine in the first three years, challenging to learn and unrelated to what students should practice later in their profession. In response to that, Barrows and Tamblyn developed a PBL curriculum to stimulate learning through considering more relevancy to physicians' future roles, more motivation towards subjects, the value of teamwork, and more self-directed learning (Barrows, 1996). This theory later adapted to other areas as in business schools (Stinson & Milter, 1996), education schools (Bridges &

Hallinger, 1992; Savery & Duffy, 1995), law, architecture, engineering fields, social work (Boud & Feletti, 1991), and high schools (Barrows & Myers, 1993).

PBL gained the highest popularity when it replaced the conventional learning methods in some medical schools in Canada (Schwartz, Mennin, & Webb, 2001). The pioneers of this theory are Barrows and Tamblyn, who proposed it in the medical school program in the 1960s at McMaster University in Hamilton. After using this method at McMaster University in Canada, for instance, it is believed that it can promote learning outcomes literally (Eng, 2000). Furthermore, PBL application in educational disciplines is believed to have two primary purposes: ensuring specific knowledge and objectives needed for the professional competencies and endorsing the lifelong learning as Engel (1991) named it "effective adult learning".

The American physician and educator Howard Barrows wrote his book *Problem-based learning: An approach to medical education* in 1980, and he highly emphasised the application of PBL in medicine education (Pagander & Read, 2014). Barrow believes that the conventional teaching methods and learning lack in preparing physicians to use the knowledge obtained from the medical schools in real-life and practice. For Barrow, "[l]earning from problems is a condition of human existence. In our attempts to solve the many problems we face every day, learning occurs" (Barrows & Tamblyn, 1980). He believes that learning from our daily life problems can prepare us for future issues, and this kind of learning has an unforgettable nature. He also mentions the role of other people's problems, which we can learn from them or together to come to a solution, is significant.

PBL mainly focuses on involving learners to "student-centred learning in small groups leaded by a tutor or 'expert', rather than teaching using traditional lecture teaching. The role of the tutor is to guide the students toward discovering answers on their own rather than to simply provide the correct answer" (Pagander & Read, 2014, p. 5). Working in small groups in PBL pays off the best outcome as individuals can increase and understand the knowledge, enhance the serious intellectual powers, boost lifelong learning skills, and develop teamwork skills (Barrows, 1996).

In different parts of the world, PBL is viewed by industry, government, and commerce that believe learning obtained here is the result of "the process of working toward the understanding or resolution of a problem" (Ertmer & Glazewski, 2015, pp. 89-90), that is important for investing lifelong learning advancements.

PBL can be described as an effective pedagogical approach for organizing curriculum, involving students in solving a problem as a stimulus, which pays off deep learning (Boud & Feletti, 2013). Because the main idea of this approach is that problem should be the starting point of learning, a query or a puzzle, for instance, that the learner wants to solve (Boud, 1985). To solve or approach the problem, students start seeking the appropriate knowledge. Through their way of searching, they understand the learning issue and generate essential hypotheses via enough curiosity and motivation, which are the characteristics of problems (Ross, 1997). Terms like 'problematic' (Tam, 2000) and 'puzzlement' (Savery & Duffy, 1995) are considered a powerful stimulus for organising learning.

By observing the table, a customized teaching/learning model or method seems to be highly closed to PBL, as researchers define the PBL;

> as an approach to teaching and student-centred learning, in which these are steeped in the practices of real projects, team-work is used to solve problems and also to foster the development of skills and attitudes, including group work, self-initiative and cooperation, and being co-responsible for one´s learning. (Santos & Soares, 2013, p. 1).

There are numerous researchers in different branches of science, arts, and humanity that highlights the positive role of PBL in enhancing 21st-century competencies, such as Barell (2010); Gwee (2009); and Talat and Chaudhry (2014) to name a few.

The mechanism of PBL is mainly classified as a learning process and learning technique. The first one refers to a sequence of activities or processes towards achieving a specific target. While the latter, which are the ‘techniques’, can be termed as special methods of doing something (Mayor, 2009).

PBL Process

In the initial stage, learners start asking what will be needed to improve a situation or solve a problem (Boud & Feletti, 2013). This is called ‘facilitator method’ by K. D. Moore (2001), and these facilitators motivate students to attain a PBL goal. To accomplish this objective, students are involved in the investigation and originating knowledge process, making them use their current knowledge. Through this process, students are involved in applying their existing knowledge, the problem to be solved, and their social context (Tam, 2000). Learning takes an active learning form, as students construct their knowledge actively, which is consensus with the constructivism theory (Crotty, 2000). Active learning is the character of PBL and is different from the traditional ‘spoon-feeding rote’ (McKay & Kember, 1997), in which the focus is on learning through instructions and lectures. Active learning in PBL creates an atmosphere, which a dynamic interaction occurs between the students and the learning meanings; the process has dominance by the learners rather than demanding by the instructors (Kwan, 2000). As an instructional strategy, PBL has these common characteristics:

1. The starting point for learning is a problem (that is, a stimulus for which an individual lacks an immediate response).
2. The problem is one that students are apt to face as future professionals.
3. The knowledge that students are expected to acquire during their professional training is organized around problems rather than the disciplines.
4. Students, individually and collectively, assume major responsibility for their instruction and learning.
5. Most of the learning occurs within small groups rather than lectures (Bridges, 1992).

Furthermore, the goals of PBL, as described by Savery (2006), are twofold; firstly, encouraging a profound realization of content subject matter, and secondly, cultivating learners' higher-order thinking instantly. PBL does not have a static form, and it can have many forms regarding the targeted disciplines and the curriculum's intended goals (Savery, 2015). PBL intends to add “learner autonomy, active learning, cooperation and collaboration, authentic activities, and reflection and transfer” (Ertmer & Glazewski, 2015, p. 90). Besides all the approaches in PBL, there are some common principles of PBL, in academic (educational) and professional directions, as shown below:

Table 7: PBL Principles Based on (De Graaff & Cowdroy, 1997).

Educational	• Students are responsible for their learning • Co-operation rather than competition • Active acquisition of knowledge and skills.
Professional	• Holistic orientation towards professional practice • Integration of knowledge from different domains • Integration of knowledge, skills, and attitudes.

Proponents of Problem Based Learning (PBL)

PBL has been formed due to the influence of several predominant theorists and thinkers and their theories. Below description highlights the main influential contributors of it:

1. Piaget: Cognitive Development Theory

Piaget was viewed as one of the most prominent researchers in developmental psychology in the 20th century. As a biologist and philosopher, Piaget is interested in finding out the biological impacts on 'how we come to know'. One of the points he distinguished human beings from the other animals was; a human can make 'abstract symbolic reasoning'. He is considered as one of the constructivist learning theory figures (Huitt & Hummel, 2003).

In his 'Cognitive Development theory,' he was looking for how organisms can adapt to their environment. According to Piaget, mental organisations (schemes) can control behaviour (adaptation to environment) and represent the place they live. A balance is required between schemes and the environment (equilibration) (Jean Piaget, 1976). In his theory, he mentions two processes that every individual uses to adapt to his/her environment: assimilation and accommodation. Assimilation represents the attempts made by individuals to change the environment and put it into 'pre-existing cognitive structures' (von Glasersfeld, 1974). Accommodation is accepting something in the environment through changing cognitive structures (Huitt & Hummel, 2003). In theory, Piaget divided cognitive development over four stages from childhood to adulthood in human life: 1) Sensorimotor stage: this is the earliest stage (from 0 to 2 years) when a child starts to discover the environment around throughout senses and physical activities. 2) Pre-operational stage: this stage starts (from 2 to 7 years) in children's lives, in which language development is swift. In this period, children learn 'symbolic function' where images are being created, and descriptions are being progressed, depicting something according to something else. Moreover, 'intuitive thought' is advanced, and they can classify thoughts and objects through making relationships between them. 3) Concrete operational stage: it starts after seven years, until 11, this stage is called a replacement period of the intuitive thoughts to their logical reasoning thoughts. 4) Formal operational stage: this stage initiates from 11 years until adulthood; in this phase, abstract ideas and a high level of thinking will be promoted to solve problems (Ültanir, 2012).

What is significant in Piaget's theory to know is his cognitive constructivist thinking about learning. Piaget ensures that human beings should not be given information, which can easily and immediately be understood. It should be in a way that they have to think and construct their knowledge instead (Jean Piaget, 1953). This supports problem-based learning in education.

2. Kolb: Experiential Learning Theory (ELT)/Learning Cycle Theory

David Kolb, the American organizational psychologist, published his book *Experiential Learning: Experience as the Source of Learning and Development* in 1984, which has influenced the teaching route, especially for teaching/learning adults of 16 years old and upwards (Robotham, 1995). For Kolb, learning is "the process whereby knowledge is created through the transformation of experience" (D. A. Kolb, 2014, p. 49). It is called 'Kolb's experiential learning theory' (A. Y. Kolb & Kolb, 2005; D. A. Kolb, Boyatzis, & Mainemelis, 2001). According to this theory, optimal learning occurs when learners undergo the four cyclical processes of learning suggested by Kolb. The four cyclical processes of learning are: "(1) Concrete Experience ability (CE), (2) Reflective Observation ability (RO), (3) Abstract Conceptualization ability (AC), and (4) active Experimentation ability (AE)" (Abdulwahed & Nagy, 2009, p. 284), as shown in Figure 10. This process can be applied to teach an entire class to enhance students' learning (Healey & Jenkins, 2000).

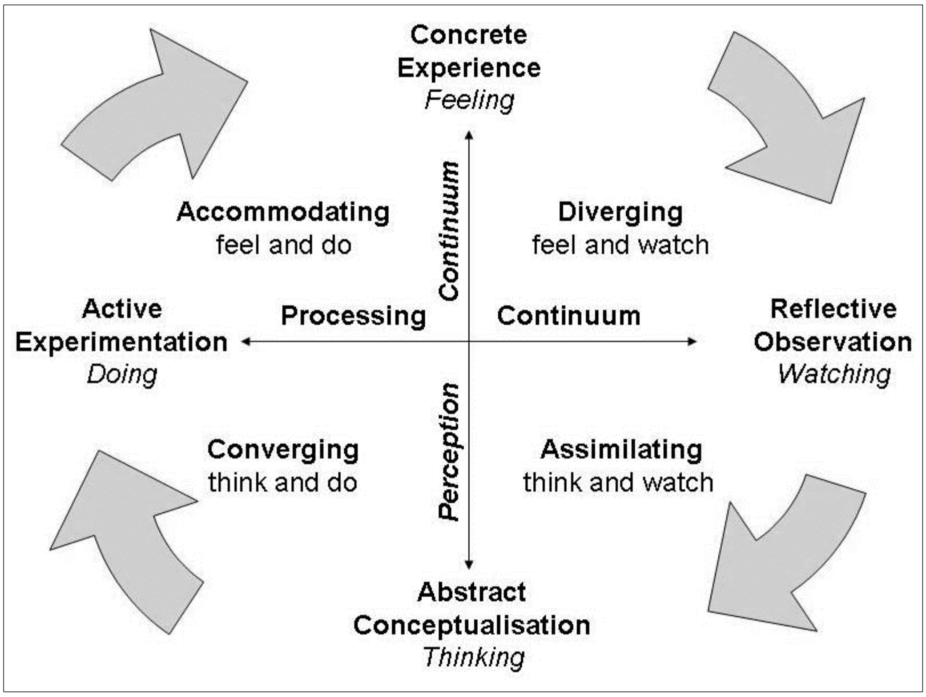

Figure 10: Kolb's Experiential Learning Cycle (Farrow, 2011)

Individuals are different in learning, this framework has the potential to give more flexibility to the learning demands and raising the awareness level of the learners; “[i]t is not enough just to do, and neither is it enough just to think. Nor is it enough simply to do and think. Learning from experience must involve linking the doing and the thinking” (Gibbs, 1988). Kolb’s experiential learning theory (ELT) has many practical applications in guiding curriculum for a diversity of science branches and professions. Healey and Jenkins (2000) summarised Kolb’s learning theory for geographical studies in higher education. They suggested ELT for their purpose, as shown in Figure 11 & Figure 12.

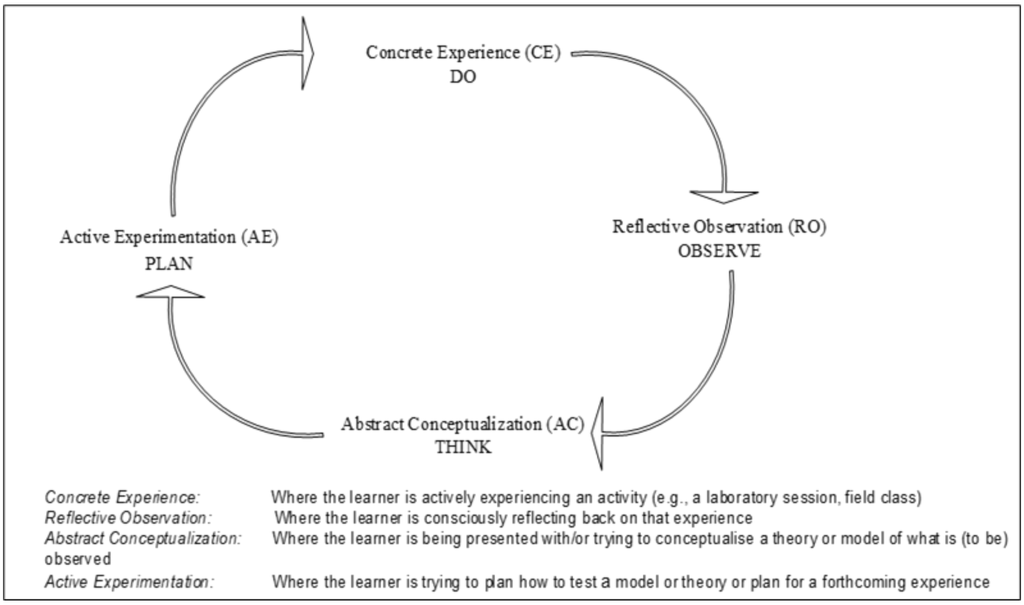

Figure 11: Kolb’s Experiential Learning Cycle (Healey & Jenkins, 2000)

In this way, “ELT has been widely accepted as a useful framework for learning-centred educational innovation, including instructional design, curriculum development, and life-long learning” (A. Y. Kolb & Kolb, 2005, p. 196).

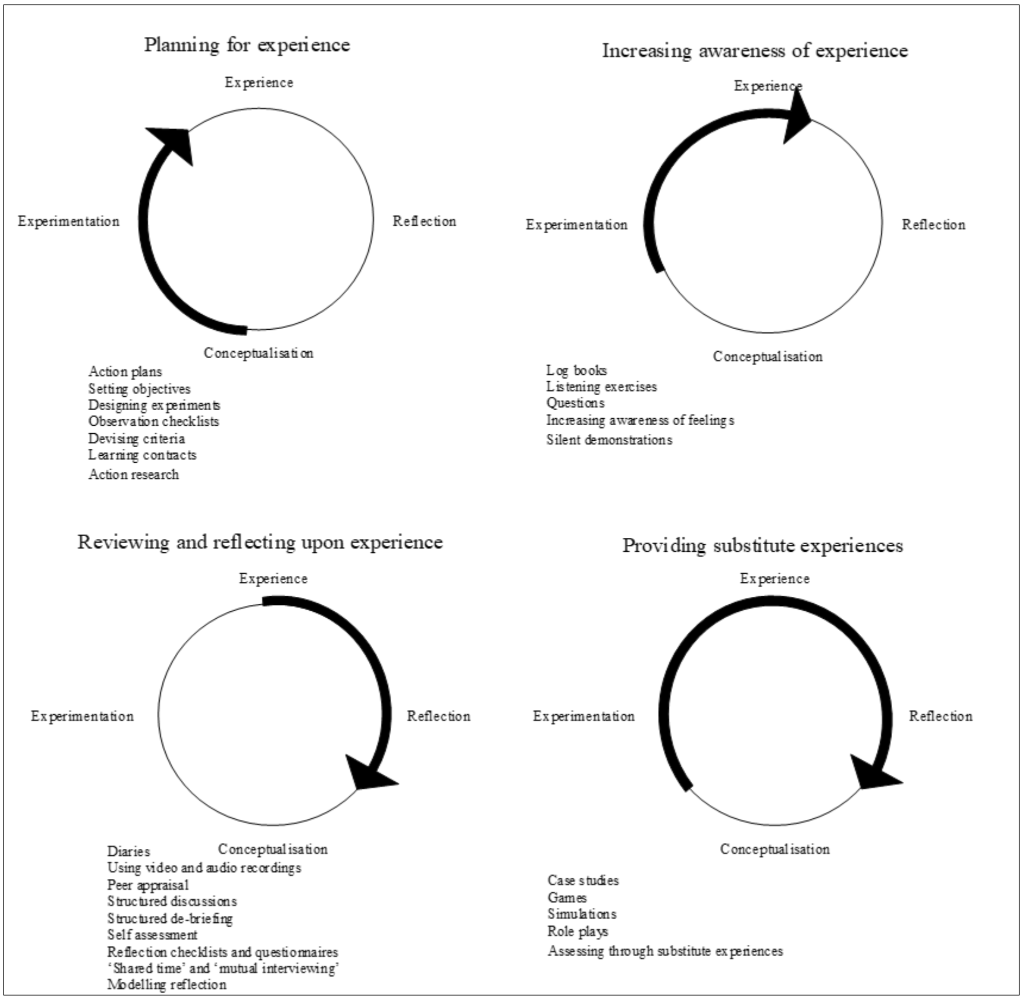

Figure 12: Practical Usage of Kolb's Experiential Learning Theory for Geographic Subject in Higher Education (Healey & Jenkins, 2000)

What is more, ELT has an instrument called the Learning Style Inventory (LSI) and developed by David Kolb in 1971 (McCarthy, 2010). LSI, a practical evaluating instrument, has been applied by many studies such as D. Brown and Burke (1987); E. Jenkins and Holley (1991); Togo and Baldwin (1990); to evaluate students learning styles. Also, to know which stage in the ELS has priority by students (diverging, assimilating, converging, and accommodating) as shown in Figure 10.

3. Vygotsky: Zone of Proximal Development and Scaffolding

Vygotsky, the Russian psychologist, is well-known for his prominent participation in learning theories. He mainly looks for the importance of social interaction and learning milieus in learning and knowledge acquisition. He also focuses on the positive potential role of peers in the adult learning process. He recognized that learners could learn best from their social learning context and each other. In these learning settings, people construct signs, concepts, and numbers to express and construct the world they belong to (D. C. Phillips & Soltis, 1998). Cultural artefacts (beliefs, science, arts, and language to straightforward things as pens, spoons, etcetera.) and social interaction together form learners' psychological development (Vygotsky, 1980). For this reason, "[t]he role of social mediation in the internalization process has been strongly emphasized in socio-cultural theory" (Shabani, Khatib, & Ebadi, 2010, p. 238).

The Zone of Proximal Development (ZPD) concept was developed by Vygotsky in the 1920s and underwent many elaborations after his death in 1934. This concept is "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with a more capable peer" (Vygotsky, 1980, p. 86). The idea is describing the actual learning development a learner can achieve alone compare to what he/she attains "through the use of mediating semiotic and environmental tools and capable adult or peer facilitation" (Shabani et al., 2010, p. 238). The ZPD concept is being widely applied in learning settings, highlighting the better learning outcome through collaborations among peers and more skilful people to gain new concepts. Roosevelt (2008) took his main educational model from Vygotsky's concept to keep the learners in their ZPD by merely giving them culturally meaningful problem-solving activities, more difficult than those activities they try alone. After the learners can solve the problem and finish the task, they are likely able to do the same task alone next time (Chaiklin, 2003). Here in ZPD, as well as the 'scaffolding' notion, which is used interchangeably in researches, the emphasis is on collaboration between learners and teachers based on constructing knowledge and skills when students are involved in a problem-based activity (Fernández, Wegerif, Mercer, & Rojas-Drummond, 2002).

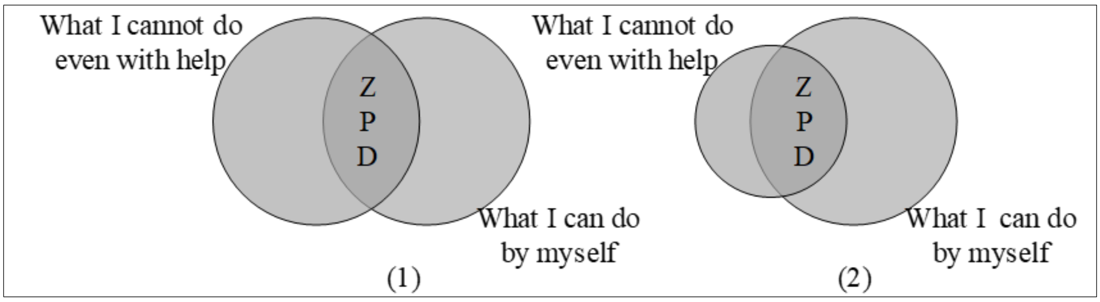

Figure 13: ZPD (1) Before Teaching, (2) After Teaching, Adapted from (Shabani et al., 2010)

4. Dewey: Learning by Doing

> *Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand. - Confucius, 450 B.C.*

John Dewey was one of the most influential American philosophers in the field of education. Dewey believed in the unity of theory and practice as such “all principles, by themselves, are abstract. They become concrete only in the consequences resulting from their application” (Dewey, 1997, p. 20), while he does not believe in every experience is educative.

Furthermore, there are three assumptions, which Dewey’s ‘learning by doing’ has been based on:

1. People learn best when they are personally involved in the learning experience;
2. Knowledge must be discovered by the individual if it is to have any significant meaning to them or make a difference in their behaviour; and
3. A person's commitment to learning is highest when they are free to set their own learning objectives and are able to actively pursue them within a given framework. (quoted in Ord, 2012, p. 55; Smith, 1982, p. 16).

According to Dewey, learning occurs best when it is strongly linked to practicing it because there "is an intimate and necessary relation between the processes of experience and education" (Dewey, 1997, p. 20). Dewey's theory in learning is a cyclic process, which loops in the plan, does, and review, as shown in Figure 14 below:

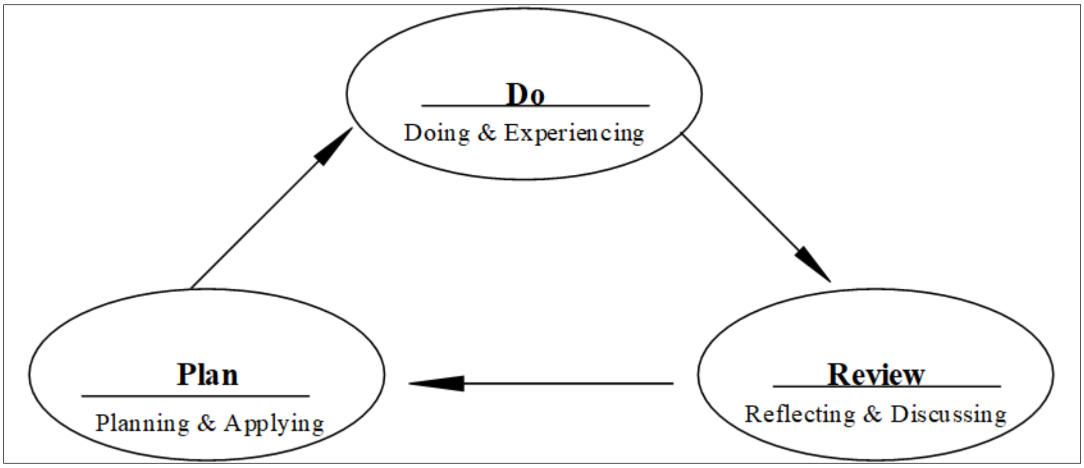

Figure 14: Experiential Learning Cycles, Inspired by Dewey's Learning by Doing Theory, Adapted from (Neill, 2010)

John Dewey believes that "the school must represent present life-life as real and vital to the child as that which he carries on in the home, in the neighbourhood, or on the playground" (Dewey, 1897). Then teachers must present problems arising from these real-life situations. Moreover, whatever is taught in school from mathematics, reading, writing, etcetera should align with it. Thus, learning needs to be relevant and practical rather than theoretical and passive (Wenger, 2010).

5. Schön: Reflective Practitioner

Donald Schön, as a philosopher who spoke on several fields from philosophy to professional practice to design (Waks, 2001). He conducted his Ph.D. research on John Dewey's experiential learning theory and developed inquiry-based learning (Buwert, 2012). For Schön, 'problem setting' is entirely essential for designers before they start to solve the problem "[w]hen ends are fixed and clear, then the decision to act can present itself as an instrumental problem. But when ends are confused and conflicting, there is yet no 'problem' to solve" (Schön, 1991, p. 41).

Schön's most significant contribution is introducing both reflection-in-action and reflection-on-action, which he prioritizes in dealing with education and profession. For reflection-on-action, Schön proposes it as a substitution for the 'technical rationality', a concrete, measurable, and rational knowledge is obtained from what is happening around towards solving a problem. Simultaneously, reflection in action, which is called 'thinking on our foot' is a process of acquiring knowledge spontaneously as an artful activity. "It involves looking to our experiences, connecting with our feelings, and attending to our theories in use. It entails building new understandings to inform our actions in the situation that is unfolding" (Smith, 2001). A real-life example of reflection-in-action can be working off a physiotherapy student with a client, for instance, making decisions about which exercise is suitable and judging the exercise right away during the activity (Jie & Perlis, 2012).

Reflection-on-action, on the other hand, refers to thinking about what you already did after taking the place of the activity or action, to know how you were successful or not in the decisions and actions (Korthagen, 2001; Schön, 1991). The same example mentioned above can be taken for reflection-on-action, but this time the student starts thinking about his decisions after the event ended. This time is to know if he made the right decisions. According to Schön, learning can happen in both cases; and that learning has a problem-based nature.

Table 8: Summary of Schon's Theory, Adapted from (URL2, 2014).

Reflection-in-action	**Reflection-on-action**
• Experiencing • Thinking on your feet • Thinking about what to do next • Acting straight away	• Thinking about something that has happened • Considering what you would do differently next time • Taking your time

From the literature mentioned above about learning theories and those pioneers in this field who support problem-based learning (PBL), there is an apparent endorsement of PBL, leading to lifelong learning. **Error! Reference source not found.** below shows t he summary of learning theorists according to the teacher's role, type of learning, learning environment, and outcome.

Table 9: Learning Theories (PBL) Proponents, Adapted from (Pagander & Read, 2014).

Outcome	**Environment**	**Learning type**	**Teacher's role**	
Schemas developed	Provide a suitable environment for students to explore themselves	Self-exploration, assimilation, and accommodation	Formal Operational, Self-directed	**Piaget**
Learning is an uninterrupted process based on experiences	Experimental learning, creative reflection, the formation of concepts, practical application.	Concrete experience	Student-centred according to their preferred learning style	**Kolb**

Social interaction initiates cognitive development	Authentic, relevant activity	Authentic activity, collaboration	Teacher guided, push students beyond what they can do independently	**Vygotsky**
Experiential education	Hands-on	Learning by Doing	Student-Centred	**Dewey**
Experimental reflection	Solving problems that don't fit in their previous knowledge categories	Problem solving and reflection	Student-Centred, where the teacher takes the role as a counsellor and guide challenging their previous knowledge	**Schön**
Development of problem-solving skills	Problems form the organizing focus and stimulus for learning, relevant and authentic situations	Self-motivated, self-directed learning	Student-centred, learn in small groups, teachers are facilitators or tutors	**Barrows**

Compared to the traditional learning (behaviourism), as shown in Figure 15, learning in PBL that complies with constructivism undergoes an actual process of inquiring and finding out hidden sides of a problem, which at the end, based on the involvement of the learners in the problem and solving it; a solution will be prepared and have the potential to be applied. This process looks like the design process in finding solutions for the problems, and designers are educated on the same basis.

Design education is an exceptional kind of education. According to Lawson (2005), "[d]esign education, like the design itself, will probably always be controversial. Traditions have grown up, which show structural variations not only between countries but also between the various design fields" (p. 8). Perhaps, arguments about design education are due to the complex nature of design, which is believed that it is not a mystical power but like many other skills as music or sport can be taught and learned by doing and practicing.

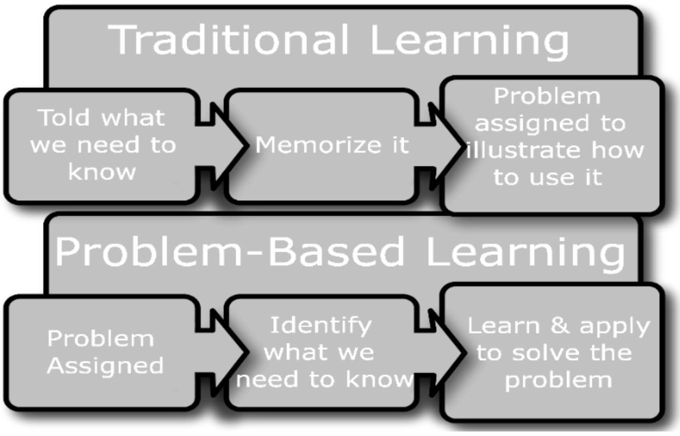

Figure 15: Problem-based Learning Compared to Traditional Learning (URL1, 2018)

Marshall (2009) explains that "[d]esign is no longer just a vocational, trade-oriented activity driven by industry… but rather a methodology with potential application to almost any kind of problem—the focus has shifted from object to process or system" (p. 10). Moreover, today designers are involved in social problems, organizational structure, more interaction, and experience design, which was not seen at the early time of the design process (Norman, 2010). That is why becoming a designer would not be just about earning a living but should contribute to social and communal responsibilities, as Van Zandt (2011) claims:

> Future designers will acquire success not by simply how smart they are by studying traditional subjects or to those who have master technical skills. It will go to those who are able to comprehend both the problem and the context of the problem and how to design or create solutions that are efficiently and aesthetically desirable for the community.

Skjold (2008) points out to the significance of design and its education and explains that design and practice are to "produce ideas and design solutions that demand a high level of education, skills, and creativity" (p. 211). It means that design education requires suitable educational pedagogies as the design itself is about solving real-life problems.

Architecture probably has a central position in the spectrum of design, and it is the most written about (Lawson, 2005). Pioneers in this field have tried to benefit from teaching pedagogies and interconnect them to the discipline of architecture. Like other sorts of designs, architectural design is about the material transformation of the world (Dilnot, 1982). According to Salama (2008), architectural design pedagogy should be towards a training form of manifesting the ability to conceptualize, coordinate, and execute the idea of building after all. Learning of it is "mostly facilitated by doing, with very little 'chalk and talk'" (Souleles, 2013, p. 250). Unlike some other disciplines as maths or history, which have some kind of 'learning by rote', the teaching of architectural design (as a branch of design) also needs a particular hands-on type of approach (Hall, 2016).

According to Marriott (2012), architectural education is a combination of art and science. This education "dwells in the physical and virtual worlds. It swings the pendulum from objective to highly subjective" (Marriott, 2012, p. 4). It challenges to provide a high theoretical background and to prepare candidates for practice; think, and act; the profession in reality. Architecture education seems to challenge for those who accept architecture as a discipline. "Those who see architecture as a discipline of design and building tend to emphasize the study of it, while those who see architecture primarily as a professional practice of designing and building emphasize the doing of it" (Teymur, 1992, p. 17). There is a dichotomy between these two groups, one group; focuses on the design and manual skills, while the other mostly pay attention to the theoretical dimension. Vitruvius in ‘The ten books on architecture’ addresses the importance of balancing the two sides as:

> It follows, therefore, that architects who have aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their pains, while those who relied only upon theories and scholarship were obviously hunting the shadow, not the substance. But those who have a thorough knowledge of both, like men armed at all points, have the sooner attained their object and carried authority with them. (P. Vitruvius, 1914, p. 44).

Considering what is described above, architectural education as a branch of education is a multifaceted subject that should respond to changes and alterations. Vitruvius mentions that an architect's education should be consistent with the knowledge in various branches of science and different kinds of learning. He presumes this diversity in knowledge as the mother of practice and theory.

Similarly, Anderson (2011) emphasizes the necessity of multi-layered knowledge in the design process. Biggs (1999) defines learning as:

> …a way of interacting with the world. As we learn our conceptions of phenomena change, and we see the world differently. The acquisition of information in itself does not bring about such change, but the way we structure that information and think with it does. Thus education is about conceptual change, not just the acquisition of information. (p. 60).

The most effective education could be the one that instils meaningful information and leads to that conceptual change. Dewey (1997) believes that learning is an experiential process-oriented, not product-oriented activity. It means that the most focus needs to be on learning as a process rather than the final designed projects. Friedman (2003) proposed that design education should focus on thinking skills rather than making artefacts. Deplazes (2005) believes the best thing a university or an institution can do is to teach students how to teach themselves, which “includes: the independent establishment of basic premises, critical analysis, and intensive research, advancing hypotheses and working out syntheses" (Deplazes, 2005, p. 10).

Some researchers, as Doyle and Senske (2016), mention that architecture learners need deep learning; what they mean by deep learning is "what most instructors would recognize as productive and transferable learning, yet few courses achieve. Architectural studios are examples of a deep learning environment" (p. 195). 'Learning by doing', 'reflection in action', ' self-learning', and ' reflecting on previous experience', are all familiar teaching and learning approaches and strategies in architectural education, which result in promoting an in-depth learning approach (Bradley, 2000; R. Brown & Yates, 2000; Schön, 1991). So, design studio as one of the deeply rooted models in architecture education is still imperatively valid and has its significance, where students can be involved in solving complex problems and learn actively and deeply due to critiques and learning from each other.

To link the philosophy behind the design studio model and its characteristics (a PBL, game-alike, and a social learning environment) in architectural education to the teaching/learning theories. It may help us think of the same philosophical idea for teaching/learning technical courses as technical courses are a significant part of this education.

3.3.4.2 Student-Centred Learning

According to Rogers (1983), student-centred learning is an approach that learners can choose not only the subject of study but to have the right to know how and why the subject of interest is necessary. It is "instruction is a form of active learning where students are engaged and involved in what they are studying" (J. K. Brown, 2008, p. 30). It is also the incorporation of experiences in the educational milieu, which makes students feel more engaged, motivated, and responsible (Dewey, 1986; D. A. Kolb, 2014). All of the experiential learning cycles, problem-based learning, and discovery learning are examples of methods applied in student-centred learning (Viti, 2014). A student-centred approach is not new; its emergence dates back to the 1900s in the United States, coming from the constructivism context (J. K. Brown, 2008). Constructivism, as a teaching method, started from works of pioneers of education Dewey and Vygotsky. According to constructivism, learning by doing should replace learning by observing (Dewey, 1963). This approach is now in use in many different parts of the world, and it is found that not only learning but teaching turned to be more enjoyable, which has improved students' performance (Froyd & Simpson, 2008). Teachers can share the responsibilities of learning with the students. Furthermore, sometimes, students are the ones who may come up with the suggestion of a teaching strategy to be applied in the class because nobody knows better than them how best they learn (J. K. Brown, 2008).

Student-centred learning leads to what is called life-long learning (Bauerova & Sein-Echaluce, 2008). Life-long learning can be achieved through the "[u]se of different learning strategies and learning in different settings, [b]asic learning skills and intellectual powers, e.g., critical thinking, [u]se of learning devices" (Marra, Camplese, & Litzinger, 1999, p. 8). That is why it is said that life-long learners take some responsibilities for the required task, and teachers do not do the task on their own. Instructors' role mainly revolves around creating the environment, monitoring the learning process, and assist students in acquiring life-long skills and reflecting on these skills (D. R. Woods, Felder, Rugarcia, & Stice, 2000).

Beyond the learning theories mentioned above, students' approaches to learning are also discussed by researchers and psychologists as the *surface approach*, *in-depth approach*, and *strategic approach*, which are explained below:

1. Surface learning: in this approach, students learn only to pass the exam and accomplish the least requirements of a learning program (Howie & Bagnall, 2013), without having enough motivation to ask questions and real involvements to the platform subjects (Biggs, 1999; Chin, 2001). Students of this approach perceive the tasks as external annoyances, no integration occurs, and no strategies are reflected (Norton, 2009). The primary focus is on how to memorise it for a limited period. Finally, the approach involves learners, as it is clear from the name, a surface ability related to cognitive skills, and finishing the tasks at hand with minimum effort (Biggs, 1999).
2. Deep learning: This approach, on the other hand, refers to a route in learning in which learners adopt interaction with the task content in a way relate new knowledge to their previous knowledge and empowering the link between them and to the everyday experience. For instance, in the exam, they try to answer with logic and combine evidence into their responses (Rosie, 2000). For that reason, "[d]eep learning approaches utilise higher-order cognitive skills, by meaningful engagement in learning and thinking conceptually rather than amass detail" (Ham, 2003, p. 11).

3. Strategic learning: in the third approach, students can customize one of the approaches mentioned above, surface or deep, for a particular task in their studies. This state may be the outcome of some external stimulations such as teacher's signals or the absence of learning goals in some situations. In this case, the learner's intention swings from deep to surface learning, from one subject to another, from a project to the other, and vice versa. Sometimes it is related to the demand of the tasks (Marton & Säljö, 1976).

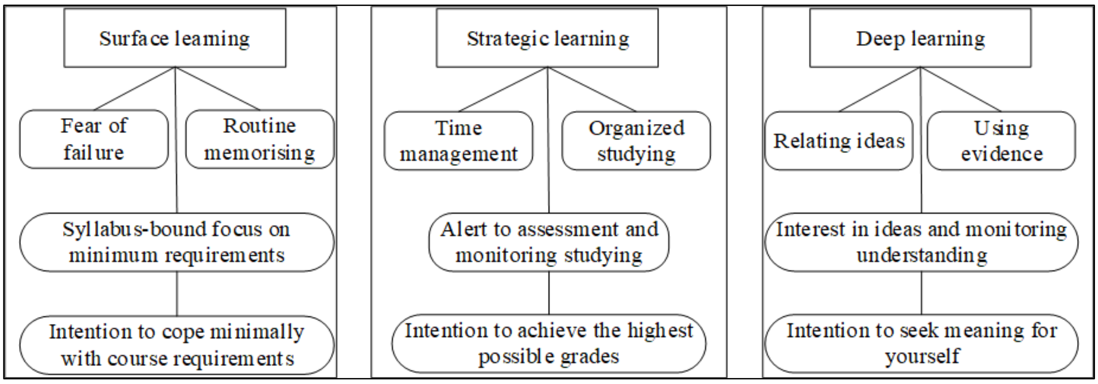

Figure 16: Students' Learning Approaches, Adapted from (Entwistle, 2003)

This study mostly focuses on parts, which are related to Problem Based Learning (PBL), and student-centred approach, to be applied in forming a framework for teaching technical courses in architectural education to encourage students towards life-long learning. Life-long learning is seen as a need for the fast-paced world where changes are rapid, and people need to learn incessantly. These concepts already have an application in architectural education in general, specifically to the design studio model.

Marton and Säljö (1976) is a pioneering study to pose these terminologies (deep and surface learning approaches); then, after many other studies elaborated on this subject, another dimension was added, such as 'strategic learning' by Biggs (1979). In later research, the subject of learning approaches is described as an action taken by the learners when learning. The questions of 'what' is experienced to know the meaning of the learning task and 'how' to know the organization of the learners' learning task (Svensson, 1997). In line with deep and surface learning approaches, two other dimensions have been added: 'holistic' and 'atomistic'. The amalgamation of these notions and approaches leads to further understanding of the learners' approaches more rigorously, such as a learning approach that might be 'deep-holistic' or 'surface-atomistic'. This discussion is further illustrated in Figure 17.

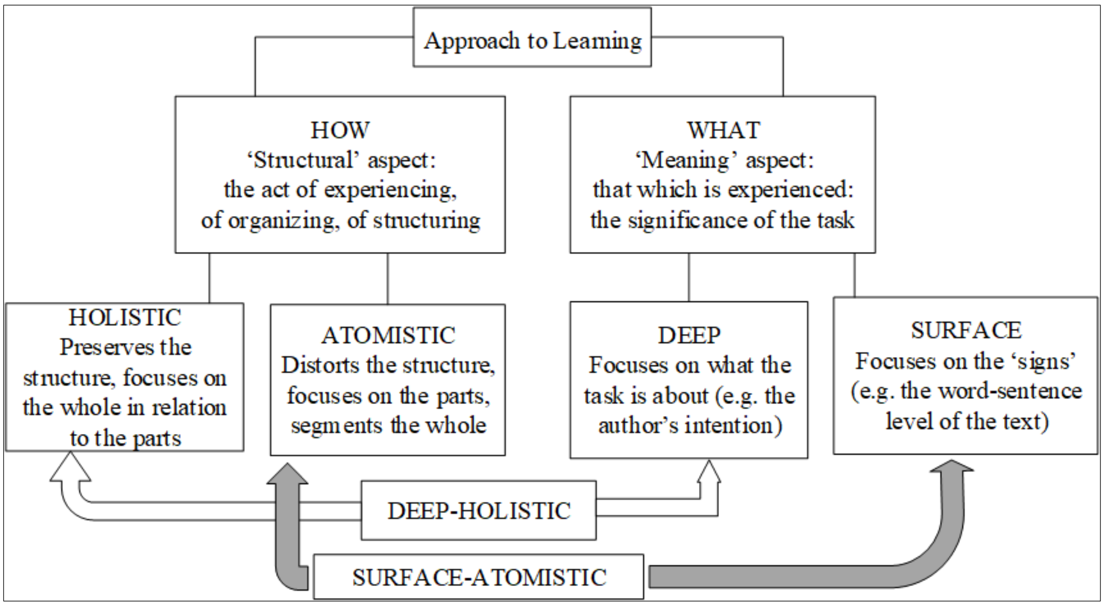

Figure 17: Development in Terms of Learning Approaches from Ganapathy Iyer (2018)

Several studies have been conducted on the investigation of the above-applied models connecting the students' learning approaches in the field of engineering and design. As shown in Table 10, these professional studies have their specific learning approaches. In computer sciences, learning will be with a surface approach, while in cases of constructional and operational subjects, the learning changes to a strategic and a deep approach (Shirley Booth, 1992). For fashion design, intention to achieve a technical competence is considered as surface learning, when considering design as both product and process is a strategic learning approach and reaching to the point that for students who intend to develop their conceptions this becomes a deep learning approach (Drew, Shreeve, & Bailey, 2001). Lastly, in computer science, and engineering department, when learning occurs inside isolated groups, student learns less, and it can be a surface learning approach. Experiencing learning in this department as an individual effort goes under the strategic learning approach, but when these changes to a collaborative effort learning approach become a deep approach (Shirley Booth, 2001). The last raw in Table 10, which represents the deep learning approach, can be targeted in the proposed framework.

Table 10: A Comparative Table on Learning Approaches in Computer Sciences, Engineering and Fashion Design (Shirley Booth, 2001).

<table>
<tr><th>Marton and Säljö (1976), Biggs (1987) Approaches to Learning</th><th>Shirley Booth (1992)</th><th>Drew et al. (2001)</th><th>Shirley Booth (2001)</th></tr>
<tr><td></td><td>Computer Science</td><td>Fashion Design Department</td><td>Computer Science & Engineering</td></tr>
<tr><td rowspan="2">Surface Approach</td><td>Expedient Approach</td><td>Intention to demonstrate technical competence</td><td rowspan="2">Learning in isolation within the group</td></tr>
<tr><td rowspan="3">Constructional approach</td><td rowspan="2">Intention to develop the design product</td></tr>
<tr><td rowspan="2">Achieving (Strategic) Approach</td><td rowspan="2">Learning as part of a distributed effort</td></tr>
<tr><td>Intention to develop the design process</td></tr>
<tr><td>Deep Approach</td><td>Operational Approach</td><td>Intention to develop own conceptions</td><td>Learning as part of a collaborative effort</td></tr>
</table>

Technical courses that are considered as science; and engineering, part of the architecture can be treated in the same way as engineering. Some considerations that emphasize having student-centred learning in engineering classes are:

- It is required by engineering accreditation to make engineering knowledge more student-centred and students to be life-long learners in this very fast-paced world of technology, to be able to adapt and to accommodate their needs in a global society (Marra et al., 1999).
- The new engineers' generation is called knowledge workers; that is why engineers must keep learning continuously to stay well-informed about the technology that they need for their employment (Wells & Langenfeld, 1999).
- "The half-life of an engineer's technical skills is 2.5-7.5 years, depending on your discipline. This means that "the vast majority of the technology that will exist in the latter part of a 40-year career has not yet been developed" (Todd, 2001). As these upcoming technologies develop the engineers are required to learn about these new technologies. That is why life-long learning is essential.
- Finally, it should be said that the best impulse for learning is learning per se. If students can alter from an extrinsic incentive (such as grades, recognition, etcetera.) towards an intrinsic one, "then the basis for lifelong learning will have been established. In engineering, there is a joy of learning associated with knowing and predicting how the world works. Students need to have opportunities to experience this" (Parkinson, 1999).

It would have a significant benefit if student-centred learning was applied in technical courses in architectural education as very often, these courses are taught in a teacher-centred approach that has made understanding these courses difficult and less enjoyable. This approach separates the courses from the design itself while these courses should go parallel to design. On the other hand, technical knowledge can be learned the same as the design is learned; learning how to learn, and these learners should become life-long learners in technical knowledge. Likely, “the need for learning how to learn is becoming more widely recognized from many different directions. It may be helpful to provide resources to these students that affirm and reinforce their inclination to initially accept responsibility for their own learning” (Froyd & Simpson, 2008, p. 5).

Researches emphasize the positive role of the design studio model frequently. For this reason, this study intends to take inspiration from the design studio model of teaching/learning through analysing the relevant pedagogical approaches and methods of learning, not thinking to put technical courses inside the design studio as a chore or introducing a second design studio for teaching technical issues. The idea of incorporation of technical knowledge to design studio showed to be unsatisfactory, and several research showed the impracticality of this idea (Allen, 1997; Kucker, 1997; Ridgway, 2003). Students of architecture in design courses are given a design problem. Throughout the process of finding the solutions, students acquire the essential knowledge. By solving several projects, students become ready to design any building and physical environment during their design education. Therefore, a survey is conducted into the most relevant teaching/learning models in the current literature, which support a student-centred approach in architectural education considering the student-centred approach instructional strategies.

Student-Centred Learning Strategies

Many different teaching (instructional) strategies have been developed in student-centred learning. A list of 28 teaching strategies has been published by 'Teach Thought staff', compiled by Mia MacMeekin, as shown in Figure 18. These strategies can be applied to many different disciplines to fulfil a student-centred approach. However, for teaching/learning technical courses in architecture, it will be logical to go back to the nature of design in architecture. As previously discussed, the design has its characteristics. It is a problem-based activity (Eastman, 1970; Oliver, Harper, Hedberg, Wills, & Agostinho, 2002), and it has a play nature (Farivarsadri & Alsaç, 2006). Coinciding with these design features, this study is preparing instructional strategies adapted to the new framework.

As mentioned above, each problem and game, which highly coincides with design, can be incorporated in the proposed framework.

Figure 18: Student-centred Instructional Strategies (TeacherThought, 2018)

Student-centred instructional strategies comprise of various variables while among them games have a broader boundary both as a theory and a strategy. Games are not just human experience and activity. It is studied that amongst animals, there is gameplay to learn essential skills in life (Becker, 2016; Ludens, 1955), and “play is more than a mere physiological phenomenon or a psychological reflex” (Huizinga, 1949, p. 1). Learning is an essential subject in any game (Dell'Aquila et al., 2016; Gee, 2005b; Koster, 2013). Furthermore, as mentioned by many people, learning through games is the most natural way of learning (Becker, 2016; Rieber, 1996).

These instructional strategies presented above like cooperative strategy, presentations, panel, discussion, small group, jigsaw, simulation, workshop, inquiry-based, problem, discovery, Q & A, social media, games, competitions, and debates, all can be applied separately or some of them together.

Game Theory

> *“A game is a problem-solving activity, approached with a playful attitude.”*
> *Jesse Schell*

Playing games has a deep root in history, in a way that it is older than culture (Huizinga, 1949) and an inseparable part of the culture (Becker, 2016). Many definitions can be to the game. Game designer Sid Meier claimed, “a game is a series of interesting and meaningful choices made by the player in pursuit of a clear and compelling goal” (McGinnis, Bustard, Black, & Charles, 2008; Rabin, 2010, p. 126). Some researchers define the game as an engagement activity by the player(s) with specific rules “[t]o play a game is to engage in activity directed toward bringing about a specific state of affairs, using only means permitted by specific rules” (Suits, 1967,

p. 148). Also, play is thought that promotes informal learning, which unconsciously or willingly happens in children and adults (Savignac, 2017).

Engagement is a prominent feature in playing games. So, it is logical to consider taking inspirations from game theory into education since engagement has a well-defined position in the educational area. More likely, many educators have been concerned and paid attention to students' engagement (S. Kim, Song, Lockee, & Burton, 2018). Shernoff (2013) illustrates engagement as "the heightened simultaneous experience of concentration, interest, and enjoyment in the task at hand" (p. 12). It is said that having 'fun' incorporated into games would soar the engagement level when fun per se is "somewhat different than enjoyment. Fun is a positive emotional or psychological state that an individual can have during or after a spontaneous and enjoyable activity" (S. Kim et al., 2018, p. 10). Thus, the game is fun, and at the same time, a serious endeavour towards achieving an indicated goal, which is learning, and "true fun is the emotional response to learning" (Leupold, 2004). This mission is tacitly implanted in playing almost all types of games.

As mentioned above, using games or playing games as a tool for learning has deep roots in history as "the Ancient Greeks used games in readiness for war, the Russian Army used strategy games, and knights in the Middle Ages used games to train" (Routledge, 2016, p. 1).

To understand the capacity of games, game theory in learning, and mechanisms of applications, it is necessary to point out these two logics; gamification and game-based learning, which are researched most.

1. Gamification

Gamification is applying game thinking or gameplay mechanics for solving a problem in a non-game activity or application (Deterding, Dixon, Khaled, & Nacke, 2011; Van Grove, 2011). From the above definition, gamification is not a single activity but a thinking process toward goal achievement. For that S. Kim et al. (2018) thoroughly elaborate on gamification as "a set of relevant activities and systematic processes …[which] should have a purpose to solve specific problems… should be based on the characteristics of game elements " (p. 28), not just using some simple game mechanics like points and badges.

Also, Palmer and Petroski (2016) report that "[g]amification is not 'playing games'" (p. xi). Instead of inputting more enjoyment and efficiency into daily life activities through applying game mechanics such as "shopping, exercising, or formatting a spreadsheet… generally resulting in better outcomes than there would be without the integration of game mechanics" (Palmer & Petroski, 2016, p. xi). It means that gamification is not about putting everything into a game (Zichermann & Linder, 2013). Nowadays, there are many examples used to learn specific skills and knowledge based on gamification, such as; DuoLingo app for learning languages, as an example. Learners play at different levels in DuoLingo according to the progress they achieve. If learners can complete a level in its time limit, then he/she earns points and a time bonus, as the motivation of the success. Knowre is another example of the gamification application in the classroom. Knowre is:

> an adaptive math curriculum which enables instructors to provide personalized instructions to every student. It helps the student to get the experience and benefits of one-on-one learning. It helps students to break concept in a step-by-step process and help them in learning with more depth and with consistent feedback and review to overcome weak areas. (Cujba, 2018).

In normal classrooms, teachers cannot give students personalized course materials, while Knowre has solved this problem.

In this point of view, gamification challenges to promote better achievement, more persistence, and higher participation through harnessing the motivational potency of games (Reiners & Wood, 2015). That is why it is said that gamification can enhance the engagement level of individuals (Reeves & Read, 2009), encourage collaboration (McGonigal, 2011), as well as stimulates human motivation (Zichermann & Linder, 2013). Moreover, it is believed that the early stage of gamification may date back to the rewards from the ancient kingdoms from thousands of years ago (S. Kim et al., 2018).

The gamification concept seems to be fruitful to apply in education mediums as it can be heard many complaints about difficulties of student' engagement in classes in many sectors and professions. It also copes with the education theory of Universal Design for Learning (UDL), which let the student have enough freedom to follow the way they learn best under their mastery and in different ways (Rose & Meyer, 2002).

Architectural education and specifically construction courses can be seen among those disengaged fields in which students have difficulties absorbing the knowledge and improving their motivation (Dobson, 2015; Yunus, 2000). That is why it needs a specific teaching method to make students more engaged and enjoy learning these courses.

2. Game-based Learning

"Play is our brain's favourite way of learning things". Diane Ackerman

Playing video games' combination in education and curriculum content is called game-based learning activity (Prensky, 2001). Sometimes the terminology of 'Serious games' is also used instead of game-based learning (GBL), which is supplying the highest quality of software and computer games, as tools, for educational purposes (Connolly, 2009). Current generation learners are called 'gamers' (Matera, 2015) have a considerable congruence with GBL. GBL can captivate learners and transform a painful and dull subject to a more engaging and motivating experience (Tang, Hanneghan, & El Rhalibi, 2009). Such an exciting activity of learning is described as 'motivation of gameplay' by Prensky (2002), and he mentions that learners experience learning with an 'open heart and an open mind'. An example of GBL is OurCity, a free Facebook game; the product of several universities and nongovernmental organizations. OurCity "allows the young players to build and develop the city from scratch with available resources and, at the same time keeping all the townspeople happy" (Sanal, 2020). The goal that needs to be achieved in this game-based learning play is to help people learn the necessary awareness in the community they live in, such as civic knowledge, finding the need of people, and making the community healthier and stronger.

GBL has been widely researched, and many researchers have concluded different positive outcomes. Gee (2003) believes that GBL, through arousing learners' curiosity, can support deep learning. Because in playing games, there is a transformation from play entertainment into "play to productive play and extending learning into gaming" (Pearce, 2006, p. 17). The process of learning through games is a problem-solving activity (Khoo & Gentile, 2008), where learners receive feedbacks to rectify misconceptions and promote learners’ understanding of the subject (Laughlin, Roper, & Howell, 2007) as well it enhances collaboration among learners (Hamalainen, 2008). Similarly, researchers like De Aguilera and Mendiz (2003) and Dziorny (2007) report that learning through games builds a confidence feeling which is specifically vital for assisting people with learning impairments such as dyslexia.

This study alleges that numerous aspects can be ascertained in game theory and can be applied or inspired by in reshaping the teaching/learning of technical courses. Game has the potential to activate human’s innate motivation, which can be sensed in our daily life, no matter what age, social rank, gender, or culture, but it is still devilishly popular. That is why the research intends to link this potency of game theory to teach/learn construction knowledge and technology in architecture. This game/play concepts have a lot congruence to PBL, which this study takes as the basis, because “[g]enerally, games provide a meaningful environment for problem-based learning” (Kiili, 2005, p. 17). Several studies have been conducted on the effectiveness of adapting both GBL and PBL together in educational mediums for various disciplines and branches of science, such as: in creative writing (Trekles, 2012), problem-solving skills by primary school students (Setiyadi, Zaenuri, & Mulyono, 2018), enhancement of student-centred learning (Rodkroh, Suwannatthachote, & Kaemkate, 2013), adoption of efficacy by the learners (Ketelhut & Schifter, 2011), to name a few. Also, “‘play’ promotes twenty-first-century cultural skills and dispositions necessary to work with others in current and future situations – critical thinking, creativity, self-control, empathy, negotiation, communication, collaboration, problem solver, open-minded, flexibility, and organizational skills” (Lasley, 2017, p. 41).

This study attempts to form a scheme to be the base for a teaching/learning method in technical courses in architectural education to achieve an in-depth learning approach by students; a student-centred learning approach. Game theory is one of the theories that form this framework to alter the learning environment to a game-like-one to benefit from all the positive potentials it can offer.

Table 11: Literature Survey for the Themes of Previous Chapters in the Study from the Selected Sources by the Author.

Themes	Selected References	Main outcome points
Considerations towards better architectural education	Salama (1995); Anter (2012); Augustin and Coleman (2012); Bashir, Ahmad, and Hamid (2013); Brookes and Poole (2012); D. C. Phillips and Soltis (2004); Dewey (1997); Doyle and Senske (2016); Farahat (2011); Farahat (2011); G. Brown and Gelernter (1989); Ganapathy Iyer (2018); Gropius (1965); Kirkland (2012); Lawson (2012); Lawton and Gordon (2002); M. Davis (1998); Mahmoodi (2001); Ridgway (2003); Samsuddin (2008); Souleles (2013); Norberg-Schulz (1966); Teymur (1992); Vitruvius (2006); Watson (1997); Zucker (1951)	• Self-directed learning; • Social learning; • Process-based approach; • Critical thinking and the ability to solve ill-defined problems; • The collaboration of practice and theory; • Quality of architecture graduates; • Knowledge of materials; • Linkage of design, technology, and environment; • Architectural totality; • Culture-based problems in design; • Technical knowledge; • Collaborative and interdisciplinary practices; • The balance between practical and formal instruction; • Learning from nature; • Sociologist teaching; • Provision of physical, social, and aesthetic needs of society; • Better education; • Quality of instructors; • Problem-solving pedagogy in design education; • Learning by doing; • Improving thinking skills; • Deep learning
Learning	E. Phillips (1982); Samsuddin (2008)	• Learning is problem-solving; • There is no perfect learning method; • It has complexity;

Themes	Selected References	Main outcome points
PBL	Barrows (1996); Barrows and Tamblyn (1980); Boud and Feletti (2013); Bridges (1992); Crotty (2000); Eng (2000); Engel (1991); Ertmer and Glazewski (2015); Kwan (2000); McKay and Kember (1997); Pagander and Read (2014); Tam (2000)	• Promotes learning outcome, life-long learning, effective adult learning, active learning; • Process-based and student-centred; • Effective pedagogical approach for organizing curriculum; Involving students in solving a problem; • Solving problems in a social context; autonomous, collaborative, and cooperative learning; • Learning from problems is unforgettable; • Student-centred, small group works, instructor lead students to find answers not providing answers
Game theory (Play/game, GBL; Gamification)	Becker (2016); De Aguilera and Mendiz (2003); Dell'Aquila et al. (2016); Deterding et al. (2011); Gee (2005a); H. Jenkins, Clinton, Purushotma, Robison, and Weigel (2006); Tang et al. (2009); Kiili (2005); Khoo and Gentile (2008); Koster (2013); Lasley (2017); Leupold (2004); Ludens (1955); McGonigal (2011); Palmer and Petroski (2016); Reeves and Read (2009); Rieber (1996); H. Jenkins et al. (2006); Salen, Tekinbaş, and Zimmerman (2004); Santos and Soares (2013); Savignac (2017); Tang et al. (2009); Van Grove (2011)	• Learning is the goal of many games; • Play promotes deep learning unconsciously or willingly; • Play promotes twenty-first-century cultural skills; • Enhances engagement and it is fun; • Can teach life skills; • Learning can occur best through games; • The market widely applies game; • Gamification has a process and solves the problems; • Gamification enhances collaboration, motivation, and engagement; • GBL is a problem-solving activity; • GBL is significant in learning; • Learning through games reinforces confidence; • Playing games activates motivation in learning; • Fosters the development of skills and attitudes; • Games accelerate PBL; • Play, PBL, and Semiotics are interconnected

Based on Table 11, the relations between the key themes were defined, and it was found that architectural education mostly may slant towards the outcome points which are originated from constructivism, such as: self-directed learning, process-based approach, learning-by-doing, etc. Consequently, both PBL, and game theory share the same characteristics. That is why the parallels between them can contribute to the offered framework. These relationships are shown in Figure 19.

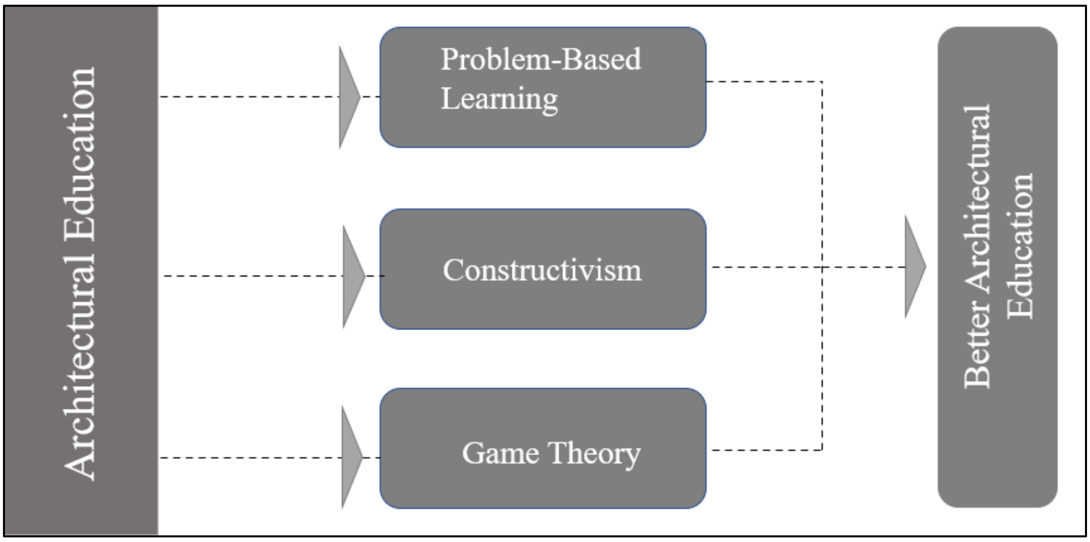

Figure 19: The Relation Between Main Themes by the Author.

To adapt what is going on regarding SCL, PBL, and learning in design, the study assumes that if design and technical courses are complementary parts of what is called 'architectural totality' (Haddad, 2010) and technical knowledge and design in architecture are indispensable (Uzunoglu & Quriesh, 2012), i.e., then a successful design thinking should embrace technicality of it too (Latif Rauf, S Shareef, & Ukabi, 2019). Based on this relationship, what works for teaching/learning design may work for teaching/learning technical courses, too. For this reason, in chapter four SCL instructional strategies, PBL and methods that cope to the nature of learning in the design studio will be emphasized.

To fulfil a student-centred approach in teaching/learning technical courses in architectural education that may cope with the 21st -century competencies, a learning theory, which is constructivism, has a congruency. Constructivism, either consciously or unconsciously, is applied in the design studio, where students learn through a PBL application and a social learning environment. Design projects are ill-defined problems that students get involved in solving them. Instructors are in the facilitators' role and manage a process-based scenario from the inception of the project until the end. What students learn in the design studio is not a specific skill about just several projects they take. Instead, they learn how to approach problems, even finding out potential problems and trying to reach a solution.

3.4 Chapter Summary

The focus of chapter three is on investigating teaching/learning theories that cope with 21^{st} -century competencies and teaching/learning in the design studio. Through surveying the literature four main basic learning theories, behaviourism, cognitivism, social learning theory, and constructivism have been studied. It was found that what is going on regarding teaching/learning in the design studio originates from constructivism. Moreover, constructivism adopts both PBL and student-centred learning approach as shown in Figure 20. Being familiarized with the nature of the design studio, the same pedagogical method of learning/ teaching based on PBL model, which its origin goes back to constructivism can be used for teaching/learning technical courses through thinking of instructional strategies derived from student-centred learning. In some way, technical courses can be driven into the same environment as the design studio has. This can be possible through finding the links to assimilate the knowledge to be delivered in these courses in problem-based scenarios, and games. Both ways are among instructional strategies of the student-centred learning and from the nature of the design. As a result, students may have better contributory roles and learning through experience.

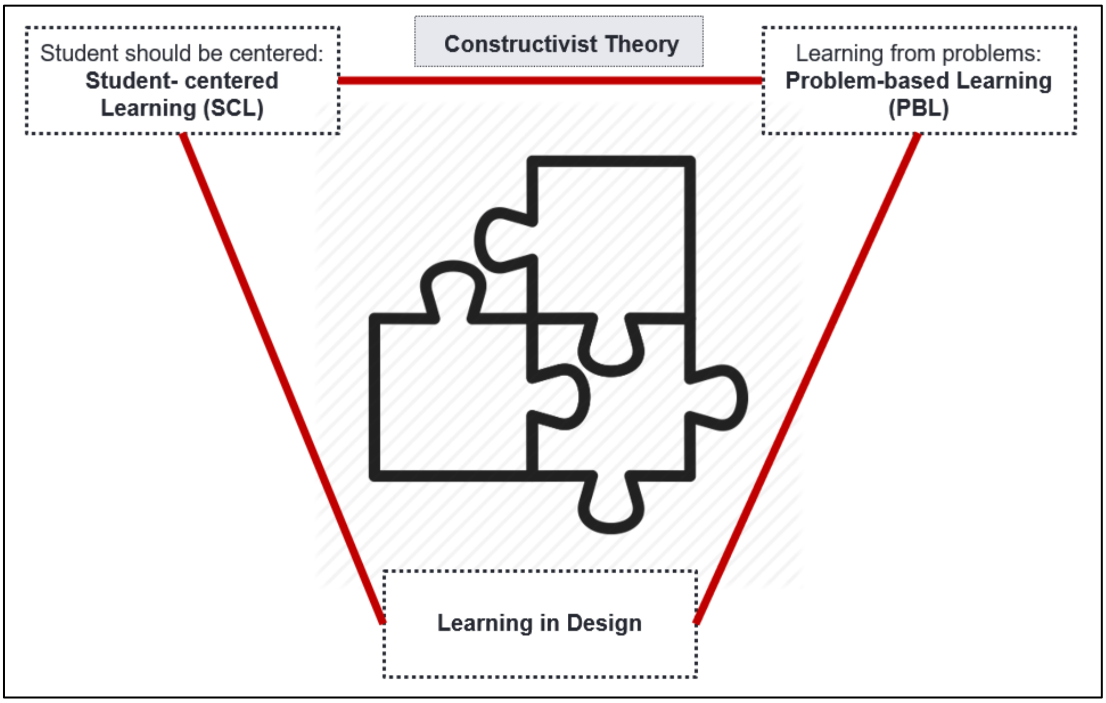

Figure 20: The Relationship Between Student-Centred, Problem-Based Learning, and Learning in Design.

As the consequence of the current chapter, 21st -century competencies, constructivist pedagogy, and design studio model converge together to assist forming the framework to be applied in technical courses by this study. This means that the study benefited from teaching techniques (from design studio model), learning approach (from constructivism), and pedagogical method (from PBL, originated from 21st -century competencies). Then, principles, strategies, and specifications of them are demonstrated. As the outcome of it, the new framework is organized the appropriate pedagogy to be used is 'PBL' with a 'student-centred' approach'. Strategies can be 'peoblem', 'small groups', 'class presentations', 'discussions', and 'games'. Moreover, techniques can be 'site visits', 'class drawings', 'gamification & GBL', as shown in Figure 21 below:

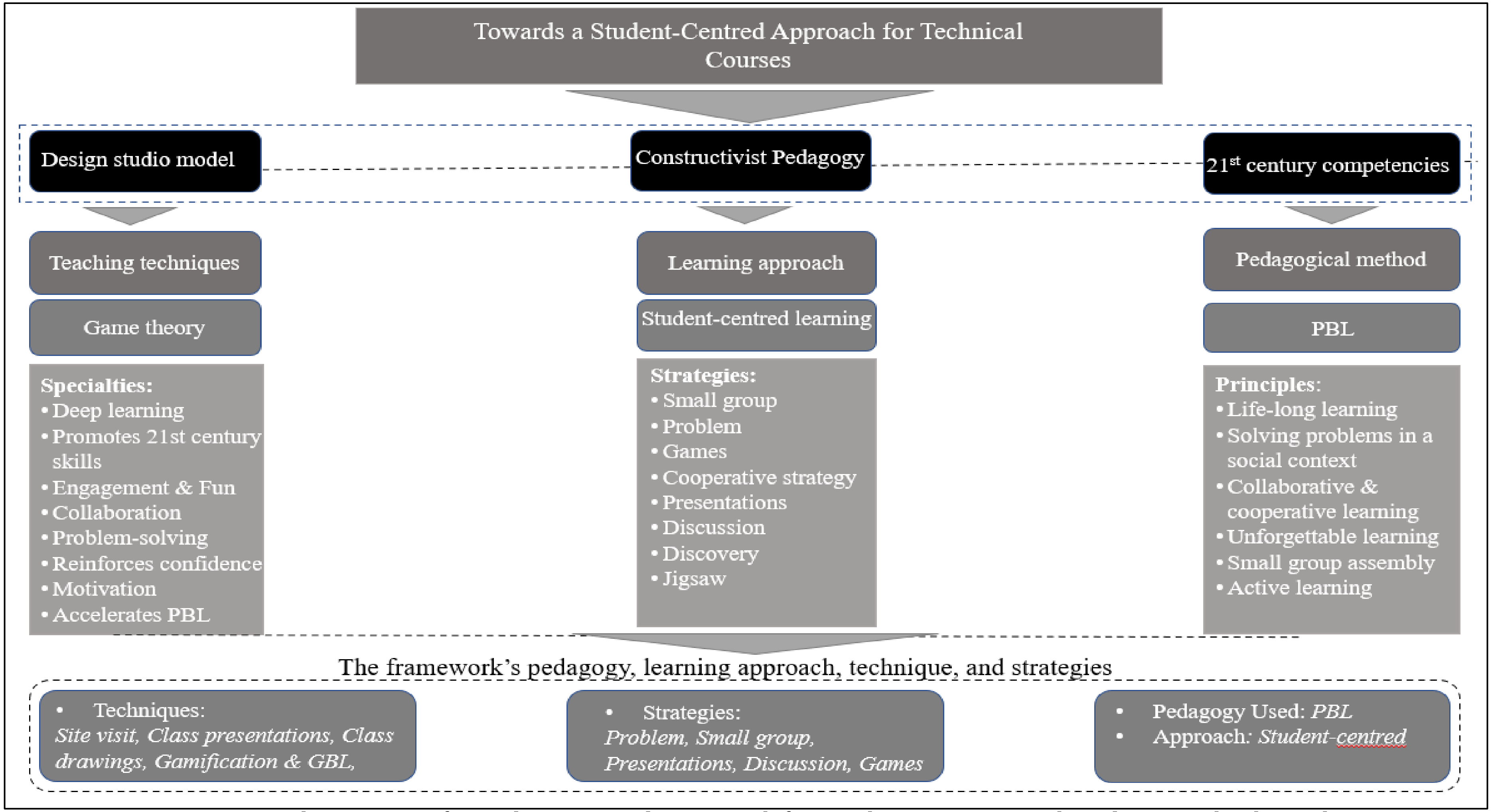

Figure 21: The Diagram of a Student-Centered Framework for Teaching/Learning Technical Courses by the Author

Chapter 4

FRAMEWORK FOR TEACHING/LEARNING TECHNICAL COURSES IN ARCHITECTURAL EDUCATION

4.1 Introduction

Previous literature showed that a good architectural profession needs to keep up with changes including its practice and education. While, Ruedi (1998) indicates that "the curricula of most schools of architecture still rely on the nineteenth-century categorisation of architectural knowledge into the design, technology, theory, and professional practice" (p. 28). It has caused the separation of design and technical knowledge, like two sides of the same coin. The lectures of technical subjects in architecture are treated as separate courses having their own time and space. Yunus (2000) and Gelernter (1988) state that architecture students could not transfer the knowledge they gain in technical courses to their design projects, with some technical courses as the most boring subjects in their architectural education. This may be due to the methods by which the courses are delivered, which are mainly lecture-based. These methods have several inadequacies, including one-way application, which highlights the instructor's authority, the repetitive nature of the monologs, and the physical setup of classrooms (Sweeting, 2014). The synchronization between design and technical courses is essential. It can help students of architecture to think of their design projects with more self-confidence. This knowledge also allows students to be more creative in their design works. Alakavuk (2016) describes the necessity of understanding the relationship between design and construction in architectural education. She states that design and construction "must be reflected in the curriculum of architectural education in a way that the students of architecture can understand this relationship very well to comprehend the contact of these two parallel and related subjects" (p. 4). In this notion, technical knowledge should have a parallel position with design in architecture education, which is also underlined in the European policies for Higher Education (Declaration, 1999; Voyatzaki, 2002a).

The truth behind the statement mentioned above is mainly adapting a teacher-centred and passive learning method for technical courses in some architecture schools today. This passive learning results from not having an appropriate method for teaching technical courses to take students' attention, same as design, which has a playful nature, and students have a better rapport with (Farivarsadri & Alsaç, 2006).

Proper technical knowledge is among the qualities an architect needs to have because "the pace of industrialization and the advancement in the technology of the built environment are forcing architects nowadays to consider the technical feasibility of their 'design' at a much earlier stage of the design process" (Banerjee & Graaff, 1996, p. 185). Unfortunately, students of architecture have problems thinking of their projects' materiality in the real world (Carlson-Reddig, 1997).

Vitruvius' principles of good design and architecture (function, durability, and aesthetics) are still valid (Teymur, 1992). To these, two other principles, environment and economy dimensions have been added since 1970s (Thorpe, 2012). A good education secures good background knowledge for the practice. However, due to the rapid technological changes, the previously practiced-teaching/learning methods, content, and architecture curriculum seem to need customization. There are 21st century required skills, which must be thought and incorporated into architectural education.

4.2 Towards a Student-Centred Framework for Teaching/Learning Technical Courses

Curriculum, content (syllabus), and a pedagogical approach are the pillars of every educational program, and the most significant concern is the link between them. Regarding a design school, “if the focus is on the curriculum, this means that the school is content-oriented, and thus the characteristic profile is ‘vocational’. If the pedagogy dominates, this means that the school is process-oriented, and thus the profile is ‘humanistic’” (Gelmez, 2016, p. 3). Balancing both sides in a limit seems to accelerate a vocational outcome within a humanistic manner. This study looks for a student-centred framework for teaching/learning technical courses, taking out from the parallels from PBL, design, and constructivist pedagogy. This framework will not be a proposal for teaching a specific technical course. Still, it can be thought of as an inspired-by framework, which can help reorganize teaching/learning concepts in these courses.

This framework attempts to adopt a student-centred approach that may fulfil lifelong learning by the learners, which is mentioned by research, and hopes to secure a memorable, sustained, and deep learning outcome. The learning approach adopted by the learners is in the hub of this forthcoming framework, when “[t]he approach that a learner adopts will be influenced both by the individual’s conceptions of knowledge and his or her ability to manage learning” (Moon, 2013). Paying attention to theories about learning approaches lets us understand the shortages of the learning situations and the proposed solutions (Sharma, 1997).

4.3 Proposing a Framework for Teaching/Learning Technical Courses in Architectural Education

The study's proposed framework is grounded on a student-centred learning approach, highly inspired by constructivism philosophy, which focuses on learning through experience. Constructivism has several core principles that are shortly illustrated below:

> 1. Maintain a buffer between the learner and the potentially damaging effects of instructional practices.
> 2. Provide a context for learning that supports both autonomy and relatedness.
> 3. Embed the reasons for learning into the learning activity itself.
> 4. Support self-regulation by promoting skills and attitudes that enable the learner to assume increasing responsibility for the developmental restructuring process.
> 5. Strengthen the learner's tendency to engage in intentional learning processes, especially by encouraging the strategic exploration of errors. (Lebow, 1993, p. 5).

The target is a life-long learning process, which coincides with the primary objective of the study. Likely, architectural education for the 21st century, according to Wallis (2005), has to slant towards ‘diversity, teamwork, linking practice and education, creative problem solving’ all these terms are considered in the proposed framework by this study to teach/learn technical courses. The framework will be organized on problem-based learning, both as theory and a student-centred instructional strategy, as the central theme.

Figure 22 shows a step-by-step learning process based on PBL developed based on Wang, Thompson, Shuler, and Harvey (1999). This process can be customized for applying PBL process to technical knowledge, too. Like in design, in which students deal with ill-defined problems, technical knowledge-related ill-defined problems can be put into the process. Students start researching the problems through group discussions and generate new ideas accordingly. These ideas, then are organized according to the results of debates and discussions based on students' existing knowledge. Next, they begin to understand what they should learn. They need learning sources, including books, internet searches, etc, as they cannot depend on their existing knowledge alone. Through this process they construct new knowledge and base new task ideas. This is a critical stage when instructors may evaluate their task ideas to know if their ideas are flawed, good, or need reorganizations. In both cases of flawed ideas or to-be-revised ideas, students should reorganize them and go back to the previous stages and repeat the process. If the ideas are good, then conclusions are drawn, and instructors can assess what they have learned and what they can do with what they learned. In the proposed framework, the instructor's role is critical; he/she should know how to organize and contribute to the process. The instructor needs to know what to choose to be in the learning program as a learning target and which types of learning strategies he/she should apply.

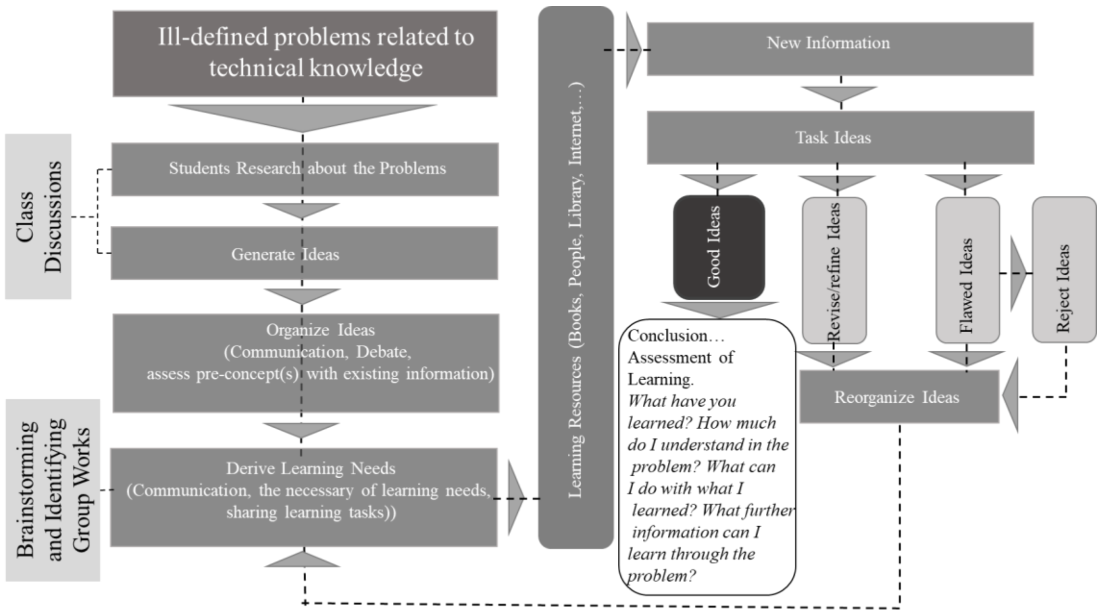

Figure 22: The Proposed Framework's PBL Process Adapted from Wang et al. (1999)

In this new framework of teaching/learning technical knowledge, there will be no single correct answer or solution to the problems that students deal with. The focus is on a broader sense, which is learning as a process. This is similar to design as interpreted by constructivists as it "is not limited to improving existing technologies or solving problems by presently established criteria. It includes the proposition of novel practices, start-up enterprises, policies, and institutions that are driven by visions of desirable futures, not necessarily informed by presently recognized problems" (Krippendorff, 2019). The whole process will unravel further venues to seek unique solutions; each group of students may have different concepts and ideas for the perceived problems. Dealing with wicked problems related to the technical knowledge, which are implied by the instructors and left for the students to seek the solutions and explore further sides of them.

Table 12 demonstrates a general consideration for the proposed framework as shown in Figure 21. In the framework, the whole process will be looking for problems in technical courses that unravel further venues to seek unique solutions; each group of students might have different concepts and ideas for the perceived problems. Students can be arranged in small groups, mostly 3-5 students in one group (small groups), whom they start to deal with the proposed problem by themselves; they will be re-directed by instructors if they feel lost or have difficulties. Learning occurs when dealing with these problems. Moreover, the overall setting depends on collaboration among the learners. The process becomes an experience for the learners that leads them to think collaboratively and see other problems to be solved as such.

Table 12: The General Consideration in the Proposed Framework by the Author.

	Teacher's role	**Learning type**	**Method**	**Outcome**
The framework	• Student-centred, group work (3-5) students (from Barrows' PBL small groups), instructors' role as facilitators	• Self-directed learning	• Problems are the learning sources; everything is based on dealing with problems • Cooperative rather than competitive • Active knowledge acquisition	• Problem-based learning for any situation • Oriented towards knowledge integration and professional practice

Teymur (2001) suggests a matrix (the second matrix) for evaluating architectural education curriculum and program that consists of a column for principles, educational practice, outcomes, and criticism. To evaluate the framework, Necdet Teymur's 4X4 matrix (Teymur, 2001), for evaluating the programme, curriculum, course or project design in Architectural Education, can be an ideal option, which can determine how the new framework can be adapted for teaching/learning technical courses.

Table 13: Adapting the Framework to Necdet Teymur's 4X4 Matrix by the Author.

Technical Courses in AE	Objectives and Contexts (why)	Objects and Content (what)	Methods and Medium (how)	Management and Structure (who)
Principles	• To sustain architectural education and profession	• Technical knowledge	• Problem-based learning	• Student-centred
Pedagogic practice	• To fulfil a deep learning	• Problems in the built environment and nature	• Through ill-defined problems in the built-environment, & nature, playing the content • Small groups	• Students by themselves via getting help from instructors as facilitators
Outcomes	• To be applied in any technical course		• Making meaning from what students do	• Students as self-directed learners
Criticism		• Needs more efforts to be organized	• Undefined method to deliver the content	• Students may feel confused at first. • Instructors need more knowledge to direct the framework

Evaluating the proposed framework by Teymur's 4X4 matrix clarifies that how the framework can be viable to be applied in teaching/learning technical courses. As shown in Table 13, both opportunities and threats (criticism) have been evaluated. Regarding the factors to be concerned in 'Principles', 'why, what, how, and who' can help categorising what should be included and thought in the framework. Same for 'Pedagogic practices, outcomes, and criticism' in the column regarding 'why, what, how, and who' every consideration is designated and the outcome of the table is seen as this framework can be applied to teach/learn technical courses under Teymur's 4X4 matrix.

4.4 Scenarios for the Framework to be Applied in Technical Courses

The study attempts to propose some scenarios for the prepared framework that can further illustrate the mechanism for applying it. Scenarios are chosen based on the framework (shown in Figure 21), which are discussed below:

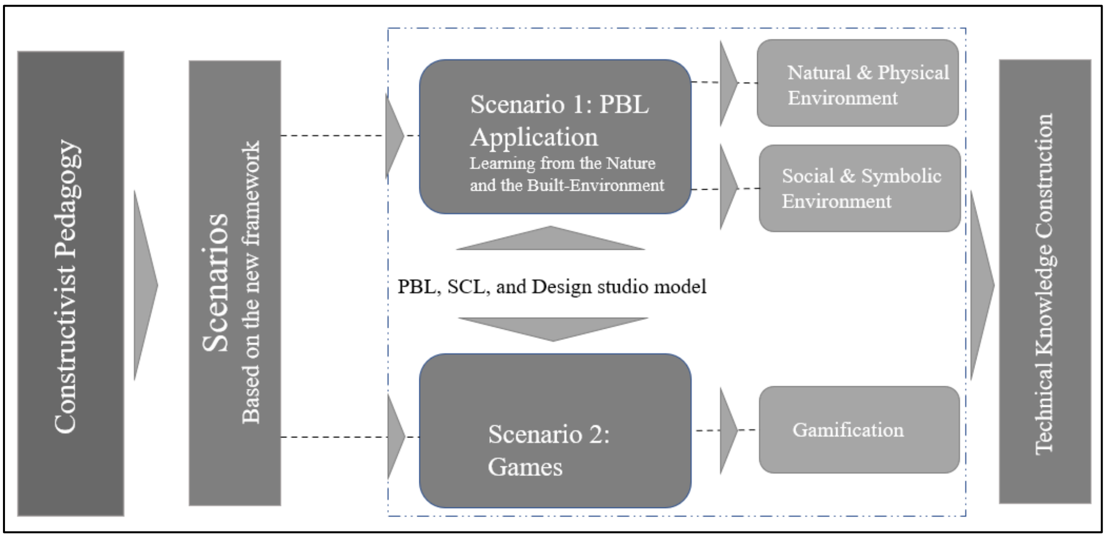

Figure 23: Scenarios Proposed Based on the Framework by the Author

4.4.1 Scenario 1-PBL Application: Learning Technical Knowledge from the Natural and Built Environment

Nature, and built environment can always be the most inspiring source for learning. This is even more meaningful for architecture because in having nature as a trainer, the aim is to create architecture sensitive to its surroundings. Students of architecture should also be equipped with knowledge about environmental issues and social values. However, architects may not need to study climate directly. Instead, they just need the part, which affects building physical aspects.

The lack of proper technical knowledge and not being aware of environmental issues can result in architectural works that have serious disastrous on the human environment and nature. In teaching architecture, if the focus does not stay on how the everyday environment works, it is like teaching medical science without considering human body functions. Thus, knowledge from the environment is vital in this profession. Therefore, in architectural education the educators should sustain links among design ideas, environmental knowledge, and existing technology.

Piaget's studies on spatial experience assisted Norwegian architect, architectural theorist, author, and educator, Christian Norberg-Schulz, who is considered as a prominent figure in both the science in architecture and theory. Norberg-Schulz's idea is from a different era, around the middle of the last century. However, due to the relevancies they make with constructivism ideas and the built environment, it helps this study's aims. According to him, the interpretation of place is an individual experience via automatic interactions and personal readings. The built environment can help individuals in this process, where buildings are designed to represent and reinterpret their context (Sweeting, 2019). Piaget's studies on child psychology influenced Norberg-Schulz to broaden his horizon and better understand the world, more specifically the built environment, along semiotic dimensions and to develop the concept of 'architectural totality' (Habib & Khosro, 2012). Norberg-Schulz divides the designed, built environment by architects into three categories: physical milieu, social milieu, and symbolic milieu.

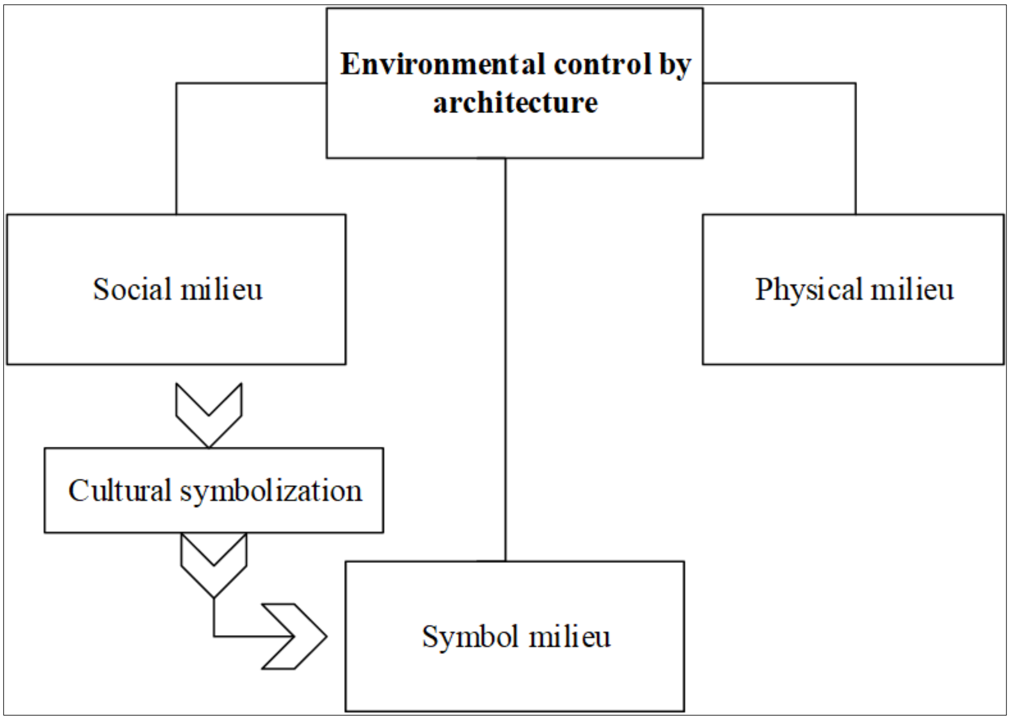

Figure 24: Controlling Environment by Architecture, Compiled by the Author from Norberg-Schulz (1966)

This study proposes a scenario as the application for the framework suggested by this study, which can deal with open-ended problems. One possibility is learning from the built environment controlled by architecture due to its intervention and formed physical, social, and symbolic settings. The aim of linking the built environment to PBL, a strategy for a student-centred approach, is crystal clear, where the built environment is full of inspiring problems, which we can learn best from them. It has great significance in architecture. It is like an evaluation for the built environment created by us (architects); again, it has been checked to know how architects could think of solving the building problems against natural environment effects. The main aim is to learn technical knowledge during this process.

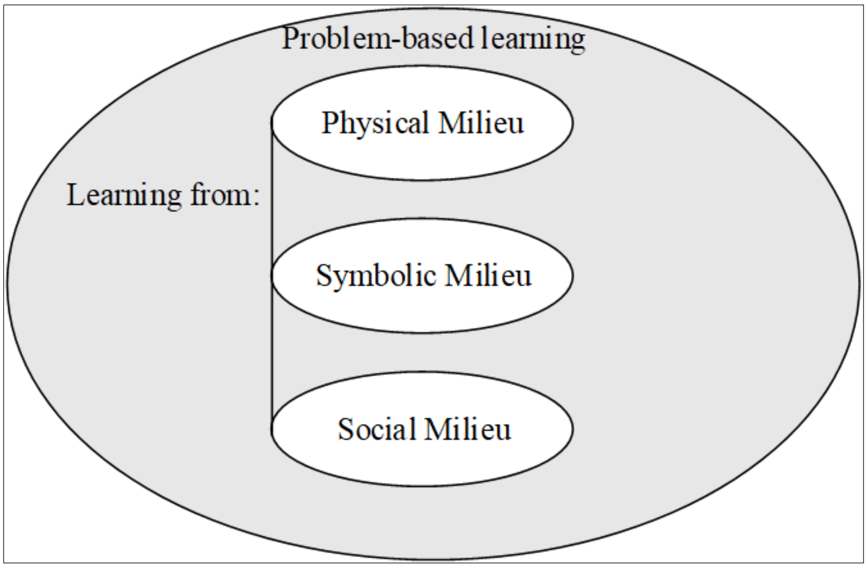

Figure 25: Learning from Physical, Social, and Symbolic Milieu by the Author

Furthermore, this intention to deal with architecture in that comprehensive and diverse way can be an excellent answer to existing challenges in architectural education. Among other challenges, the new architectural education problem is to reassert the links between design, technology, and meaning.

Through design and technical knowledge integration, the idea of architectural totality inspires this study to act towards this idea and realize it. If architecture is a multidisciplinary area of research that combines elements from the arts, engineering, and social sciences, taking the physical environment alone, for instance, may not give an overall understanding of learning from the built environment. Even architectural education itself is not a straightforward, one-route discipline as it is hard to bundle whatever an architect wants into a fair university program. That is why the scenario for the prepared framework includes all the milieus as one package. However, to show formalisation of the framework, they can be described separately below:

A: Physical Milieu

Natural and the built environment, designed by architects, can be the source of information. Environmental control (solutions for the natural environment over architecture) is a great source to learn from as every designed building is there for a purpose and designed to solve a problem. There are also challenges on how to actualize or materialise the design. One of the significant challenges, not recently, but since humans live on earth, is how to protect from environmental issues as in Figure 26. For instance, a shelter designed to protect from rain, wind, cold, heat, other animal predators, etcetera. So how these issues benefit architectural education and technical knowledge? Any one of these environmental conditions can be seen as a problem. For example, if rain is considered, there may be innumerable problems that it can cause for a building. There will be countless considerations and solutions. To propose a solution to the roof water leakage problem, they will learn about materials' characteristics and technical details, without memorising. Still, they experience it as they rule the problem, a real-life problem by themselves. Instead of explicitly posing and telling students' about solutions, they can think on their feet and be ready to face any other problem in different locations. The same as they learn how to design various building types through several projects given in the design studios. These problems are different from place to place, for instance, bushfire might be a major problem in Australia, but they may not have problems related to snow opposite to Europe. In this way of thinking, students learn a realistic way to deal with environmental problems. In this involvement in problem-solving and problem-based learning, students can adopt creativity and critical thinking. Moreover, creativity seems difficult without a collaborative learning environment, such as design studios or group works.

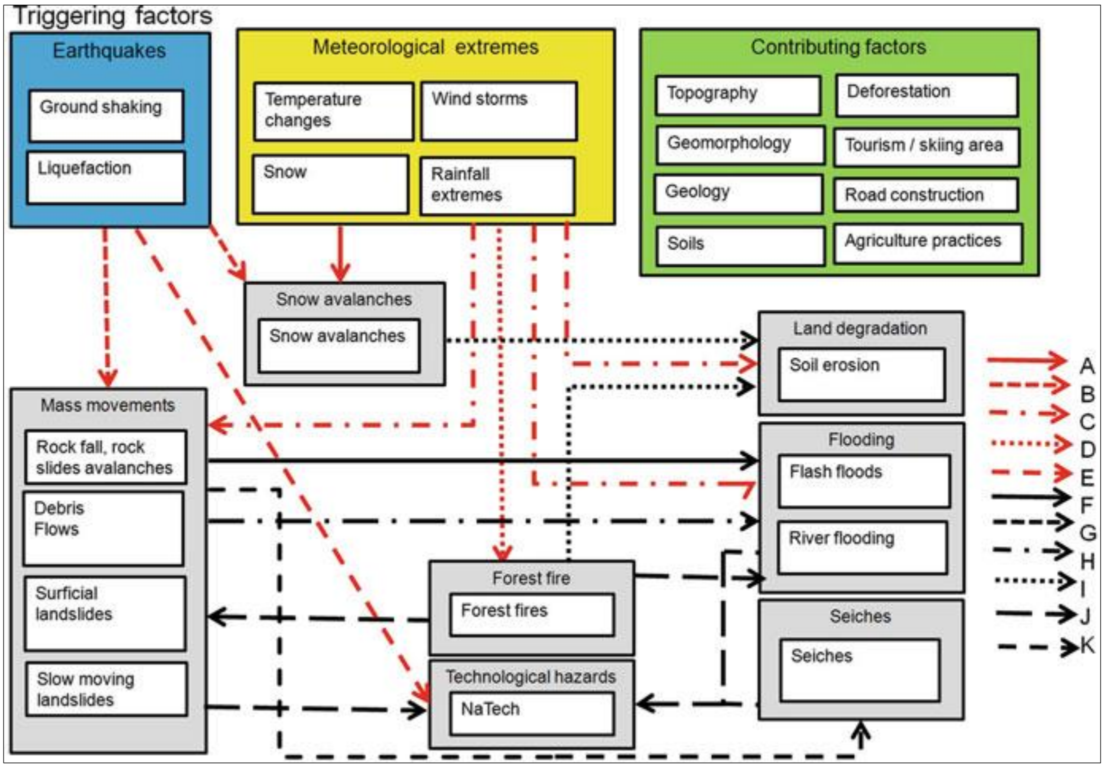

Figure 26: Natural Environment Considerations (van Westen et al., 2014)

B: Social and Symbolic Milieu

According to Norberg-Schulz (1966), environment has numerous diverse facets: the first ‘physical milieu’ is related to ‘physical control’ or creating ‘artificial climate’. Architecture creates shelters to protect human beings against environmental burdens described above. Second, ‘social milieu’ is basically about participating physical objects (i.e., buildings) in human actions. These actions are socially firmed, so this participation offers a social meaning to these artefacts. That is why buildings constitute part of humans’ social settings. Third, facet is ‘symbolic milieu’; architecture potentially represents several conceptions of cultural objects such as philosophy, religion, cosmology, etc. Cultural symbolization, together with the social milieu, forms the symbolic milieu.

Human beings construct their built environment responding to their physiological needs. Thus, when build environments are formed, they can strengthen social order or transform this order. Also, every culture uses its environment differently from another, so architects/designers are involved in culture-based problems when designing the built environment. This is what gives the built environment a meaning.

It is believed that the environment has meanings, and people react to these meanings, especially to the material objects, which activate human feelings in providing more precise images; meanings are central in understanding how the environment works. In this medium, by establishing borders and symbolically reflecting ideology and cultural rules.

Someone may ask, what are the implications of applying semiotics in the education of technical courses? Or does semiotics have any link to knowledge acquisition? For these questions, the semiotics' definition can be referred, which defined by Uden, Liu, and Shank (2001) as:

> …the study of signs as mediators of knowledge, can successfully address the problems of knowledge construction, social negotiation of meaning, reflexivity, collaboration, and multiple interactive causality, etc.… semiotics is a way of thinking about the mind and how we come to know and communicate that knowledge. (p. 42).

In the world we live in, learning can happen through direct experience or through using signs. For this reason, semiotics has a great contribution to education, whether we feel it or not explicitly.

Constructivism as the main source of inspiration for student-centred approach, which is a learning philosophy describes how people perceive and make sense of their environment by observing and interacting with their environments. People are highly interactive with the built environment when seeking meaning in it. There is a link between semiotics as a science and theory and constructivism as a learning theory. Both are about how to deal with and understand the real environment around and learning from it. Constructivism endorses an instruction that is interrelated to the world of things and meaningful for students. There is always a great chance for developing skills and objectives in solving problems coming from this realistic and meaningful setting in this real learning environment. It can also be a characteristic of the semiosis process; which helps humans build and organize the experiences, nature, and culture of understanding. For constructivists, the knowledge that could be applied to new conditions is valuable knowledge. Problem-based or case-based learning contexts that enable learners to acquire skills or expertise to solve the problem or exploit the situation are the most effective ones.

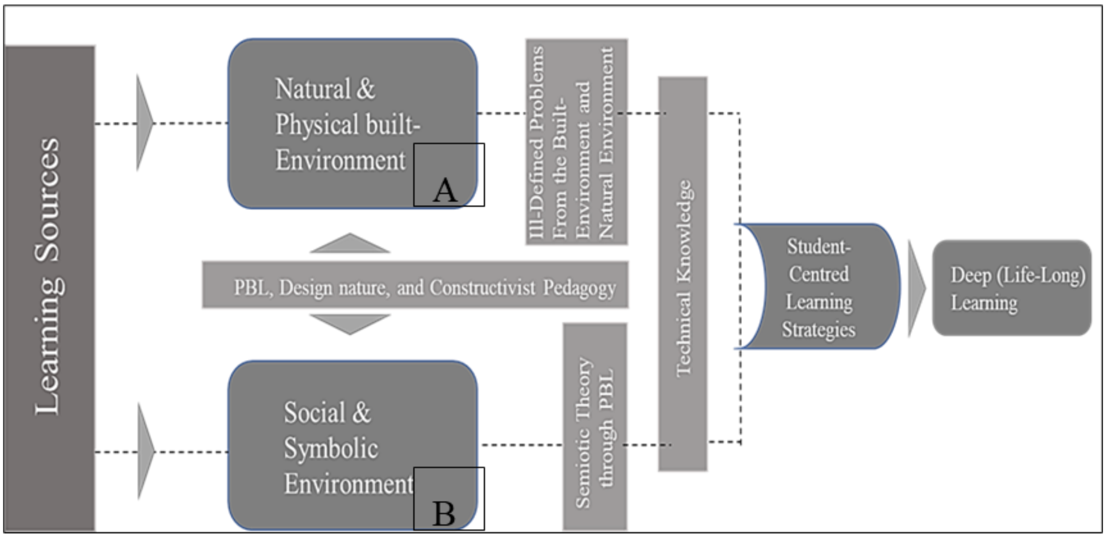

Figure 27: Scenario 1(A&B); Semiotics in Natural and Physical Environment; a Conceptual Idea by the Author

First, to link the social and symbolic environment to the technical knowledge acquisition, searching for meaning in the built environment is the ideal solution. When students get involved in a problem regarding looking for meanings, they will be familiar with an important subject, which is wisely selection of forms, materials, and symbols or whatever that may participate in this process in their design projects.

Narrowing down to building materials, the visible layer of architectural forms will be one of the major subjects for the proposed scenario to the framework of this study, the 'meaningful situation model' of Shareef and Sani (2020) can be useful.

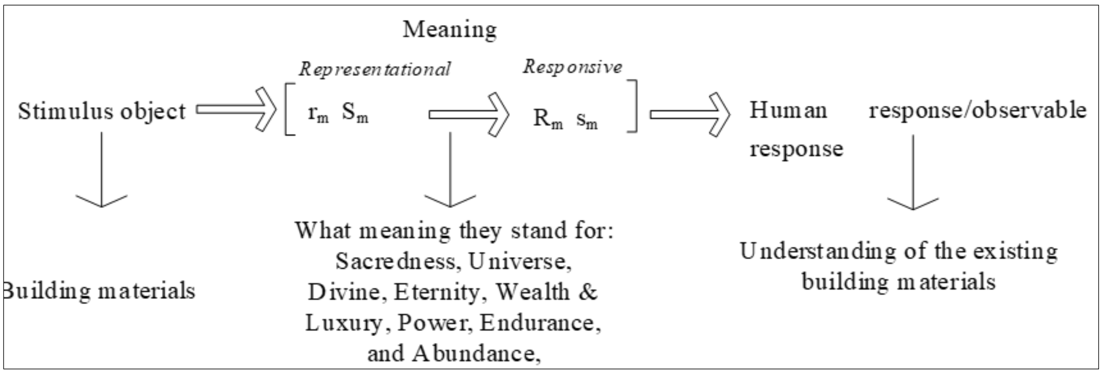

Figure 28: Meaningful Situation Model by Shareef and Sani (2020), Adapted by the Author

The 'meaningful situation model' can be applied to any building material, which learners may perceive in the built environment. When they put these materials into the formula, students can understand or at least guess what these materials mean for the existing environment and culture. In this way; learners search about finding the used building materials in the built environment and list several materials. They document them and understand what these building materials are before putting them into the meaning formula. The first step an introduction to the materials can be formed. In the next step, after the introduction, they start to know what these materials mean to this setting and people. They need both research and questioning. Then it will be time to arrange them into the meaningful situation model. That is why, until the process ends, students can be familiar with these materials, characteristics, and other technical knowledge.

4.4.2 Scenario 2: Games

Play or game is as old as human culture (Huizinga, 1949). "Play serves various functions. The most important one is learning… [it] supports fantasy, imagination, and creativity…[it] is always for fun" (Farivarsadri & Alsaç, 2006, p. 44). Learning through games is acknowledged by psychologists, Piaget, for instance. They think it reinforces cognitive developments (Plass, Homer, & Kinzer, 2015) and symbolic thinking (DeLoache, 1987).

If learning through games has all positive aspects of positive-outcome learning, previously discussed, there will not be a challenge to interconnect it to the other branches of the framework prepared by the research. Play and problem-solving are interconnected. There is also a strong link between constructivism as a learning theory and game theory, because learning in constructivism occurs when learners construct the knowledge through making meaning, which is obviously the same in games too. On the other hand, design in architecture has a game nature as well.

Reno (1992) explains that construction education (can be an) expression of innate curiosity to assemble elements logically. Her analogy is based on a toddler playing for hours with a combination of objects or puzzles to understand the world of things. In relating this to the learning of construction technology in architectural education, she criticizes that understanding this subject (construction assemblies and properties of materials) might be impossible by description.

Metaphorically, technical subjects in architectural education can have a game nature. They are about actualising design concepts to stand up due to thinking of details and material assemblies. This should be the fun part of the design process; however, construction technology is essentially mechanical, even dull, making understanding of this subject and its practical and theoretical aspects difficult for the students. For this reason, redefining and applying game theory basics (game-based learning and/or gamification) and models makes the proposed framework by this study even more attractive, and students would have better motivation to do so. In game-based learning, play attributes are dominant, and play has an extremely significant role in learning, which can activate learners' intrinsic motivation.

The mechanism to apply game theory into the framework can be through thinking of some options; one can be through gamification of the process. Vygotsky’s scaffolding will be effective in this manner. Learners need some levels of help, which is why help should be tailored according to the program's process and progress. This will be the instructor's role to know when to increase this help and gradually end it up.

Another consideration that is supported by the self-determination theory can be thought. Here learners can receive more motivation if they are psychologically stable, autonomous, and socially related. It can be achieved by providing chart bars, star ratings, points collection, learning levels, or other indicators to show the learners' learning progress. Having choices’ options, in an exam, for instance, can give learners feel autonomous. For social relatedness, if students are provided with the option to share what they may achieve as their success with other people in social media channels, it will make them more excited and engaged in the study subjects. Providing a collaborative atmosphere for students to assist each other guarantees a higher success too. Extrinsic and intrinsic motivation is essential; having all the points and bars, etcetera.

To show students' success can be an extrinsic motivation. While giving constructive feedback by instructors to make students feel control over the required tasks is intrinsic motivation. Content distribution, over time, is another consideration in learning through games. A step-by-step process can be a good thought. This makes students to be prepared for the next step. Providing knowledge quizzes are essential, which requires students to retrieve previous knowledge.

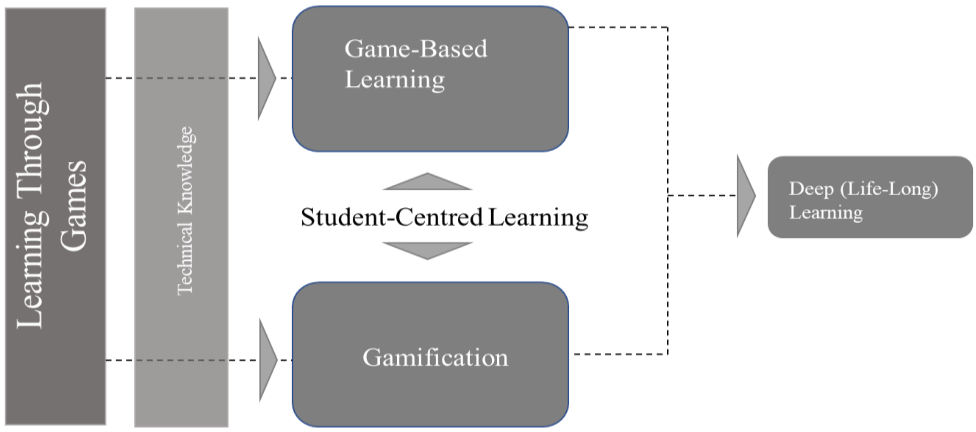

Figure 29: Scenario 2; Learning through Games a Conceptual Idea by the Author

Scenario 1 & 2 perhaps work together as all the variables have direct or indirect links; the first scenario emphasizes the content, the second one the method. Learners are imperatively required to use signs, symbols, semiotics, and meanings during learning through games. The prepared framework's conceptual idea has been illustrated in Figure 27, in which student-centred instructional strategies are applied to the semiotics and meaning-making from the natural and the built environment.

There will be more than an option for what is related to the game-based learning and gamifying the learning content and its participation in the proposed framework. Various technological tools can help this. ‘Kahoot’, for instance, which is a free website and a GBL platform, can be applied in the framework. Kahoot is a student answer mechanism that encourage learning through game-like pre-made or informal quizzes, interactions, and assessments. Instructors can instil the content into its unique pattern, which contains the above mentioned GBL basics.

Students can play the content to move them towards the problem proposed by the course and collect promotional points. Kahoot can be accessed through their computers and tablets and mobile phones without opening any accounts; for that, students can play/study every time and everywhere. Any type of information can be placed on Kahoot, options choices, videos, etcetera, and they can be timed by the instructor and through using it, which has a fun nature students' formatively can be assessed in different stages of before, during and after the course instruction. Kahoot gained high satisfaction in several professions such as English studies, nursing, engineering, and medicine.

To sum up, more than one scenario can be formulated for altering the technical schools' current situation to a student-centred approach via its instructional strategies and considering the nature of the design. This exchange can potentially change the inappropriateness of these courses' current situation towards a more lifelong learning process. Technical courses, through this student-centred approach proposed by this study, can have better congruence with design, and students of architecture can take more advantage of both the technical knowledge and their design concepts, which are going to be more logical and better designed.

4.5 Chapter Discussion

In this current study the necessity of 21^{st} -century competencies and learning in this rapid era of technology has been emphasized. That is why the relationship between PBL, student-centred learning, and learning in design (design studio model), has been considered to be used in the framework for teaching/learning technical courses. The previous chapters showed that the origin of the design studio model is constructivism, and constructivism adopts both PBL and student-centred learning. The study also intended to prepare a framework to teach the students of architecture in the 21^{st} -century which is also parallel to PBL, and student-centred learning, and game theory also has been thought as an important part of the learning originated from the nature of the design studio. For this reason, the same origin of learning in design has been applied in the proposed framework. Based on the framework two scenarios has been prepared to show the applicability of the framework.

The first scenario is learning from nature and the built environment in a PBL process; ill-defined problems from natural and built environment can be put into the PBL process guided by the instructors. In approaching a solution to the ill-defined problems by preparing presentations, group works, site visits, etc, students are expected to learn about technical subjects useful for their design projects and their profession.

The second scenario has been prepared based on the application of game theory (gamification). Games are one of the student-centred instructional strategies, and nowadays a considerable time of the adults are spent in playing games. For this reason, if games become a part of the adults' learning process may make the students to learn more autonomously. Developments of technology has made many tools available to be applied in the learning process, and the one that has been thought in this study is 'Kahoot' that students can reach the assignments and play the content that targeted easily via mobile phones, laptops, and tablets. This way of learning can make an intrinsic motivation for the students to learn more effortlessly.

As a comparison of the outcome of this study it can be said that unlike previous studies this study emphasized learning in the 21st -century, applying games and a PBL pedagogy in the framework for teaching/learning technical knowledge. The framework proposed is not for a single course but all technical courses are targeted. That is why the framework has a wide boundary that can be 'an inspired-by framework' and be adapted for each of these technical courses. The framework also evaluated Teymur's 4x4 matrix adapted for technical courses. Furthermore, the study proposed two scenarios to show the viability of the framework, both learning in the natural and the built environment through PBL gamification.

Chapter 5

CONCLUSION

5.1 Introduction

This chapter summarizes the study findings and gives suggestions for further research in this research area. This study's outcome is a theoretical framework that was developed to be applied in teaching/learning technical courses in architectural education. The subject of technical knowledge in-lined with design in architecture has been an issue during the time. Throughout history and affected by alterations in social, cultural, economic, and political situations and changing the architect's role has been changed. Even in this era of the fast-paced development world, part of the architect's role as an essential link with technical knowledge. It is also demanded by architectural accreditation boards, such as the Royal Institute of British Architects (RIBA), National Architectural Accrediting Board (NAAB), and Architects Accreditation Council of Australia (AACA). Similarly, the top-ranking architectural schools in the world dedicated a part of their curricula to technical courses. On the other hand, this technical knowledge, besides its importance, is taught mostly via conventional teaching methods (teacher-centred, lecture-based), and unfortunately, students of architecture have difficulties in digesting this knowledge.

Lots of researches have mentioned about the desynchronization of design and technical courses. However, suggesting a teaching/learning method inspired by the nature of the design itself is overlooked. This dissertation attempted to contribute to the field by filling some gaps in the previous researches. By understanding the significant role of this knowledge for architecture graduates and finding out how it is undermined (compared to design) in architectural education, this study tried to deal with the issue thoroughly. Firstly, the nature of this knowledge and the methods applied in teaching/learning technical courses were researched. Secondly, several theories and learning methods were surveyed to find the appropriate teaching/learning methods that are inlined with the way knowledge is transmitted in the design studio model, and 21st-century competencies. It highlights that if learning in design is somehow student-centred and has a problem-based learning (PBL) and game-alike nature, these are rooted and originated from constructivism theory, and the same approach can be effective for teaching/learning technical courses.

The main research question raised by this study is, *'which framework can assist instructors to teach the students how to acquire the necessary technical knowledge for their design projects?'.* This question became the study's inquiry point in finding the relevant literature and writing the theoretical framework. The present research argued that there is a need to review learning and pertinent theories for proposing a framework for teaching/learning technical courses, as the currently available methods are conventional, and there is the least attention to teaching/learning theories.

The proposed framework provides an understanding that it is possible to teach/learn technical subjects by taking instructional strategies of the student-centred approach, and the problem-based learning method, the same as in design. The framework provides the development potentials for improving an architectural education responding to changes by interconnecting design and technical side of it. As a result of it, the architect candidates can be more independent in their design thinking for different situations.

The study highlighted constructivism as the best choice to be considered in forming the framework, and found the Problem-Based Learning (PBL) as a mutual link between design and constructivism and a basis for acquiring the 21st-century competencies. Extending from that, student-centred learning was discussed and its instructional strategies were proposed. In the two scenarios that were proposed, other theories, semiotics' theory and game theory were integrated to PBL concept to facilitate the learning process. When it comes to the built environment, all physical, social, and symbolic milieu are contributed, for the physical milieu PBL can straightly be applied.

The study also dealt with the game idea to make the technical knowledge more like playing a game fitting to students' needs. In responding to this, game theory has been thought of. Technology, in this respect, can offer various options to gamify the content. Using Kahoot had been mentioned as an example, where a student can have access to the instructors' information in their mobile phones, tablets, and computers. Kahoot can also be useful to fulfil the idea of the 'zone of proximal development' (ZPD) proposed by Vygotsky. Instructors can control how much their students need the information to make them more knowledge seekers and problem solvers by themselves.

The proposed framework can also fulfil the 21st-century competencies. It is essential that future architects can keep up with the expected changes resulted from the rapid technological developments.

The framework proposed by this study depends on several variables such as learning type, teacher's role, environment, and the planned outcome:

- In the learning type, the study attempted to look for student-centred and self-directed learning by students.
- The teacher's role is to be a facilitator, and students can be arranged in small groups. The instructors' knowledge in this framework is vital because not every instructor can manage a PBL model for a specific course.
- The learning/teaching method is a problem-based one, and everything is learned from dealing with the problems.

Necdet Teymur's 4X4 matrix for the analysis of subjects related to architectural education has been used to evaluate the framework according to principles, academic practice, outcomes, and criticism by objectives, objects, methods, and management, as shown in Table 13. Proposing a teaching/learning framework by considering design nature, and constructivism learning theory can promote knowledge acquisition levels in technical subjects in architectural education. Directing students towards problem-based subjects arms them to think of their design projects and its technicality as one package and inseparable from each other. This is what is called architectural totality. Throughout the process of problem-based learning regarding acquiring technical knowledge from the built environment, students can learn much other invaluable knowledge, even the cultural dimensions to be considered in a meaningful design process.

5.2 Recommendation for Further Research

As it is evident from the name, a framework for teaching/learning technical courses can be the raw material of numerous researches in the future. Future studies could go in-depth into the framework to create teaching/learning models for different technical courses. It can also be possible to take just some aspects of the present framework in making other teaching/learning models, or the content of technical courses can be put into the framework and tested.

This study also recommends that architectural education mediums better investigate the link between design and technical knowledge through problem-based approaches as this study provided a pathway to be a threshold for future endeavours. Future research can mainly concentrate on the feasibility of the framework or a model extracted from it by applying it and observing the learning outcomes. Also, a research can be done on application of it in various technical courses.

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