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Developing a Design Framework to Methodize the Architecture Thesis Projects with Emphasis on Programming and Conceptualization Processes

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Abstract: The research develops a design framework as an applied tool to structure the necessary stages throughout architectural design programs, in particular thesis projects. The architecture thesis students apply programming and conceptualization in several different ways, and a significant proportion of them prefers to use precedents instead. Architecture thesis projects tend to focus mainly on the studies, methods, and analysis, however, the relationship between the programming-conceptualization and the rest of the thesis project seems to have attracted less attention. To cover this gap, a design framework was developed to link the architecture findings to the design objective and strategies. The research employed qualitative methods, including structured observation, and content and graphical analysis. The data were also derived from thesis students' drawings offered in the final exam. The findings revealed the potential capacity of the design framework to connect the analytical outputs with the architectural design decisions through a specific concentration on the processes of programming and conceptualization. In conclusion, the design framework could enable architecture thesis students to create a range of alternatives with regard to programming and concepts, whereas these options are still well-connected to design decisions. This will undoubtedly help students and lecturers with the creation of a systematic process of inputs, activities, outputs, and possible impacts.

Keywords: Architecture, Studio, Thesis, Design framework, Programming-conceptualization.

Introduction

Programming and conceptualization are significant parts of the education in architecture, art, and engineering particularly, in the final year as the ultimate design project (Borden & Ray, 2006; Cross, 2005; Duerk, 1993). A significant part of architecture programs is supposed to end with either a final year project or a thesis project for graduation in different universities. The policy, process, and procedure of architecture schools such as curriculum determine what kind of final project is required. While there are some differences between final year projects and thesis projects, both approaches achieve a final project to evaluate the learning outcomes of the students (Tafahomi, 2021a). In the final year project, the students are supposed to select a project to design either in one semester or in a year based on the topic, site, and guidance of the studio coordinator. In the thesis project, the students are allowed to select supervisors, topics, and methods to develop the thesis project in one year. Studies highlighted that in both approaches the role of the studio coordinator is significant due to the apprenticeship tradition (Draper, 1977; Drexler, 1975; Garric, 2017). In opposite, in some architecture schools, the

thesis approach is more developed to let the students select a research thesis based on the design proposal for one year of study to fulfill the project through the study, research, and design activities. In such program, the role of the supervisors and the panel of juries are important to lead the students through desk critics, comments on presentations, and marking pin-up as formative assessments.

The final project of the students is supposed to carry out the education experience including knowledge, skill, and ability to represent the level of the quality of design decisions by the students (DoA, 2012; FAED, 2009). Despite the confusion between the theoretical framework and the conceptual framework, seemingly, the theoretical framework refers to the studies based on the theoretical topics and outputs however; the conceptual framework refers to the research outputs and the synthesis (Tafahomi, 2021b). The studies indicate that achieving the design framework or conceptual framework is significant in the conceptualization process of the final project (Borden & Ray, 2006; Ghonim & Eweda, 2019).

Still, in some of the departments, a precedent studies-analysis process is a common way to understand the architecture projects that call learning through redrawing (Draper, 1977; Drexler, 1975; Garric, 2017). This approach has a strong root in the Beaux Art tradition that was constructed based on similarities between art and architecture in the application of drawing techniques to present their idea in terms of the final product (Griffin, 2022). In Beaux Art tradition, it was supposed that the students redraw projects of great architects in the same way art students do in art studios through redrawing the great masterpieces of great painters and artists. Apparently, creativity was meant in terms of a subjective intuition to design something new, artistic, and aesthetic (Draper, 1977; Drexler, 1975; Garric, 2017). Nonetheless, there is still some disagreement between the subjectivity-objectivity in research (Phillips, 1990) and assimilation-accumulation in the learning process (Pena & Parshall, 2012; Tafahomi, 2021c) in science, engineering, and architecture where observed creativity and concept of the design in terms of a mysterious ability in an individual, private, and personal way. While this approach of teaching was a great innovation in response to the Romanticism atmosphere in France in the 17th century to advocate the vitalization of classicism style in the directory of Nicolas-François Blondel (1618-1686) (Griffin, 2022), seemingly, the time of Romanticism have changed to the new strange context full of problems and challenges to deal through design (Dorst, 2006).

The problem of this research is formulated in this way. It is common to see the final year students are faced difficulties to apply the results of the studies, analysis, and findings in the design process (Borden & Ray, 2006). Although the students have done a long process of studies about the thematic project or topic to discover the idea for the design stage, the link between the whole process of the thesis activities and the design stage becomes a mysterious activity for the students. This problem is mentioned in terms of "Ill-structured problem" in architecture education (Simon, 1973; Dorst, 2006). The students prefer to start the design process in terms of conceptualization from their own understanding and perception of the thesis topic without a clear link to the results of the analysis. In fact, while the students do some analytical activities based on the research process or precedents studies in the studio to present the analysis stage in the project, the application of the results in the design production is not clear. In detail, the students from the topic have a straightforward movement toward the programming and conceptualization for the design of the project. However, the students are less successful to present the lessons learnt through studies and the architectural findings in the analysis stages (Tafahomi, 2021b). Seemingly, the design outputs of the students could represent a weak connection between the architectural findings and the final outputs.

In this regard, the research question is designed in some subsidiaries questions such as is there a process to like the architectural problem and

findings to the design objective and strategies? Do textural and graphical tables lead the students to accurate programming? How will be effective to detail the relationships between programs? Does diagrammatic programming lead the students to a deeper understanding of programming-conceptualization? To answer the questions, the objectives of the research are designed to test a design framework for programming-conceptualization activity in the architecture thesis studio to document the reactions of the students, analyze the outputs, and evaluate the learning outcomes of the students.

Literature review and studies on design framework

Taura and Nagai (2013) called the concept of design in terms of the most common stage in different fields of science such as engineering, art, and architecture. The study on conceptualization in engineering highlighted that the process of conceptualization at least included two stages programming and forming the idea (Pahl, Beitz, Feldhusen, & Grote, 2007). They developed the conceptualization process into four stages including planning, conceptualizing, development, and detail. According to this definition, conceptualization is a process of development that at least needs a stage in terms of planning or programming. However, another study claimed that concepts for design sometimes do not need any sketches and come into the mind of the designer such as a potter that does a pot directly from clay (Cross, 2005). Perhaps, for this reason, Lawson mentioned that reading of minds of designer is a complex task (Lawson, 2005). Nonetheless, not all concepts could be done through trial and error, nor all concepts come through a simple aspect of production, and seemingly, concepts have been forwarded for a more complex system of design products.

White (White, 1975) in his initiative work attempted to draw a guideline for the architectural concept based on the experiences in two approaches building-oriented and process-oriented and each of them perhaps includes different subordinations that he took into account in terms of values. Those values look paradoxical but represent some extreme aspects of the design such as artistic-scientific, consciousness- unconsciousness, and structured-unstructured similar to the analysis of the paradoxical relationships between the "inner-sense driven and problem-solving driven" in the thesis project of the students in the final year (Tafahomi, 2021a, p. 13).

Taura and Nagai mentioned that a concept is presented by two methods linguistic and visual. That the linguistic refers to the explanation of the logic of design such as planning and programming and the visual refers to the sketching, drawing, and presentation of the graphical ideas. The communicative tools in the architecture have included many approaches such as drawing, physical model making, and 3D animation presentation in terms of computer aids devices (CAD). Nonetheless, still, there are many problems to understand the process of conceptualization in the mind of designers, architects, and students, in which Goldman (Goldman, 2006) argued that even by analyzing the concept of the designer understanding the objective and values of the design is a complicated task. In this perspective, Mugerauer (Mugerauer, 1995) interpreted the idea of Heidegger that the latent objectives in the final products have been more than the conscious objectives of the designer, which referred to the effects of unconsciousness on the design process. This specification of the mind was called in terms of "active archive of mind" by Lawson (Lawson, 2005).

Architecture education

There is a movement in architectural education based on the philosophical transformation in the world that was documented based on the renaissance, neoclassicism, modern, and postmodern styles that referred to enlightenment, romanticism, realism and structuralism, and poststructuralism schools of thought respectively (Gomez, 2003; Hancock, 1995; Mugerauer, 1995; Proudfoot, 2000; Seamon, 2015; Tafahomi, 2021a). For example, the studies highlighted that the style of Beaux Art was based on the redrawing of the great architectural projects and providing a portfolio of drawing the great Roman architectural

projects in terms of fulfillment of the architecture education (Draper, 1977; Drexler, 1975; Garric, 2017; Griffin, 2022). This style of education in architecture continues for centuries in the world as a monologue in the educational style in which many institutes struggled to be free this style (Littmann, 2000; Madanovic, 2018; Griffin, 2022).

In opposite, there is a review on the education in architecture that referred to the Bauhaus approach in terms of integration of different styles of design and research in architecture workshops and studios such as painting, sculpture and technology (Marttila, 2018). This finding was in the same alignment with the important idea of Walter Gropius (1883-1969) that he advocated the role of education is to relieve the mind of the students from obstacles of principles to let them make a project alive (Gropius, 1970). Boradker applied the terms of multiple approaches to design education as an achievement of Bauhaus (Boradkar, 2010). In Bauhaus the traditional ateliers were replaced with workshops and studios such as clay, painting, sculpture, metal, and fabric to engage the mind of students with alternatives for design concepts, processes, and products. The applications of the different methods, approaches, and tools in the design process have a significant impact on the education process of the students (Tafahomi, 2022a).

Some architecture schools still emphasize the circle of the redrawing of the great architectural projects by the elite architecture as a way of understanding architecture and getting inspiration for the concept of architectural projects based on an orthodox tradition of Beaux Art (Draper, 1977; Drexler, 1975; Garric, 2017; Littmann, 2000; Madanovic, 2018; Tafahomi, 2021a; 2022a). This logic was constructed based on neoclassicism ideology in romanticism in the 17th century. They planned to vitalize the glory of classical architecture to represent the transcendent movement of the political power of the empire in France to train architects to design government and public buildings in terms of the "French official public architecture system" (Garric, 2017, p. 6). However, classicism was designed based on the enlightenment philosophical movement. With many changes in the 18th and 19th centuries, importantly positivism, historical dialectic, materialism, and realism, the expectation from architecture fundamentally changed and modernism took the place as the unique dialogue for design.

In this perspective, the studies argued that education in architecture, however; did not change deeply as philosophy did (Draper, 1977; Drexler, 1975; Garric, 2017), and the training of the students was even called an unmodern style of education (Garric, 2017). As matter of fact, in neoclassicism, environmental, sustainability, and psychological knowledge did not develop and the level of familiarity of the instructors was so far from the current time. For this reason, the foundation of education was based on aesthetics, order, and harmony as a Vitruvian approach to architectural design (Proudfoot, 2000). Just in the 20th century architecture schools faced with Bauhaus structure that rejected all traditional styles and searched for new ideas from reality and context (Gropius, 1970), based on movements in Europe importantly, socialism, Marxism, and modernism.

Programming in architecture

Programming is the essential and initial stage of the architecture project that in many counties was legalized as an official document in terms of an agreement between the architect and client (AIA, 2009). Hershberger mentioned that programming is a crucial stage for "functional efficiency" and both architectural "mistakes and insightful" could be happened in this process (Hershberger, 1999, pp. 2-3). Programming an architectural project perhaps is the first notion to change the condition for a better alternative that looks similar to problem solving. Apparently, the architectural programming stage is a reaction to the detected problems based on some analytical activities of architects to respond to the situation. Lang called a divergent stage of design that many solutions come into mind based on many problems (Lang, 1987). Duerk defined programming in terms of a backward-forward movement between the problem and the ideal

form for the project that perhaps could come into reality (Duerk, 1993). Architectural programs respond to the functions, activities, and environmental issues of a project based on the needs of the client, requirements of society, and essential environmental factors (Hershberger, 1999). He classified the methods for the programming into four clusters of programs including design-based, knowledge-based, agreement-based, and value-based (pp. 7-35) that referred to the assumption of the architect, some standards based on research, an agreement between client and architect, and design values respectively.

Pena and Parshall mentioned, "The programming is a process" than an event and are quite new in the architecture design. They called programming in architecture a skill to recognize the relationships and differentiation between need and want in the project (Pena & Parshall, 2012). However, they took into account the programming in terms of "problem seeking and analysis" than the initial stage of problem solving. They recommended five steps of programming in architecture including "establish goals, collect and analyze facts, uncover and test concepts, determine needs, and state the problem" in four categories of topics including "form, function, economy, and time" (pp. 14-26). They advocated that these steps could be used in all architectural projects. However, in their definition, the stage of problem definition, studies, and analysis were mixed with the programming and even with the conceptualization task that made the application of the model difficult.

Nonetheless, there are other methods for architectural programming that have rooted in the tradition of architecture education in terms of design composition which refers to the integration of different programming and arrangement into the site as a way of innovation (Gokyer, 2013). This style of programming attempted to borrow models of site arrangement and composition such as programs, functions, and activities from precedent projects and apply them to a new site in terms of the application of best practices (Draper, 1977; Drexler, 1975; Garric, 2017). In fact, programming is a new activity in architecture design that was formed in the 20th century based on new achievements in environmental and psychological sciences (Hershberger, 1999).

According to the studies, there are some approaches in the programming and planning for design in engineering, art, and architecture including four approaches that can be called architect assumption, essential standards, composition in precedents projects, and architectural problem analysis. Figure 1 illustrates the classification.

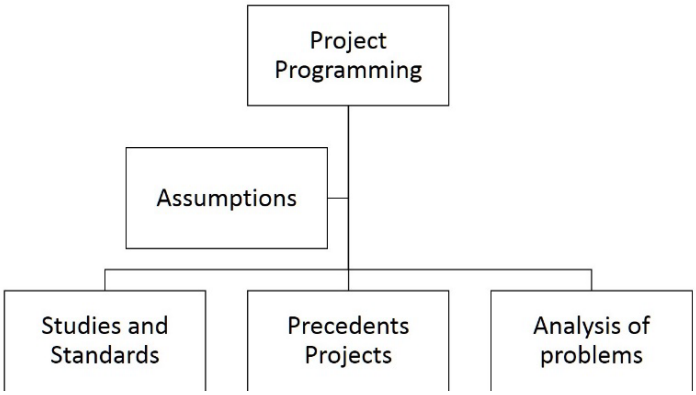


***Figure 1**: Architecture programming approaches*

Conceptualization in architecture

The conceptual design and development in architecture have been a hot and great topic for

discussion in both professional and academician literature (AIA, 2009; RIBA, 2014; Schon, 1984; Tafahomi, 2021a; 2021b). The engineering literature emphasized two stages for the design of a product importantly planning for design and conceptualization for design (Pena & Parshall, 2012) that the first task involved design tasks and the second task refers to materializing of the product. The studies also emphasized that both stages are processes than an event (Cross, 2005; Pena & Parshall, 2012; Tafahomi, 2021a) that are required a backward-forward interaction between two tasks (Hershberger, 1999).

Some studies emphasized the ability of the students to draw as a medium for conceptualization in architecture education (Ching F. D., 2010; 2015; Crowe & Laseau, 2011; Laseau, 2000). For example, Laseau (Laseau, 2000) highlighted that concept generation is a process through drawing and development of the mind that is started from the primary stage and developed into a complex idea (Goldschmidt, 2004). In the same approach, Ullman detailed the conceptualization in terms of decomposing of ideas, composition of ideas, and generation of a new concept (Ullman, 1994). In addition, Bakel (Bakel, 1995) classified concepts in architecture based on three sources including personal, situational, and international driven factors. This classification referred to the earlier classification based on subjectivity and objectivity in art and architecture (Phillips, 1990; Tafahomi, 2021c). In this case, the studies underlined that the students are under the influence of external factors such as the design studio environment to form specific behavioral patterns which was mentioned as a process of learning through observation and doing (Salkind, 2008; Tafahomi, 2021d).

For this reason, the classification of the problem-solving driven (Taura & Nagai, 2013) and inner-sense driven (Nichols & Stich, 2003) factors still are fitted to the architectural conceptualization (Tafahomi, 2021a). While this classification implies the subjective and objective approaches in design process, seemingly, art, architecture, and design are involved in both subjectivity and objectivity to some extent (Tafahomi, 2021a; 2021d). However, there are sets of critics that the subjectivity and objectivity could less appear as an absolute way and they are dependent on the social and contextual conditions to apply (Popper, 1977). Phillips (Phillips, 1990) interpreted the theory of Thomas Kuhn in terms of a paradigm that the designer follows the advocated approach by the context. Apparently, the application of each approach in conceptualization referred to the predominant paradigm in the specification of location and time.

According to the study, architecture conceptualization includes four approaches that can be listed in terms of abstract idea for development, a geometric form, composition in precedent projects, and the design objective and strategies. Diagram 2 conceptualizes the classification.

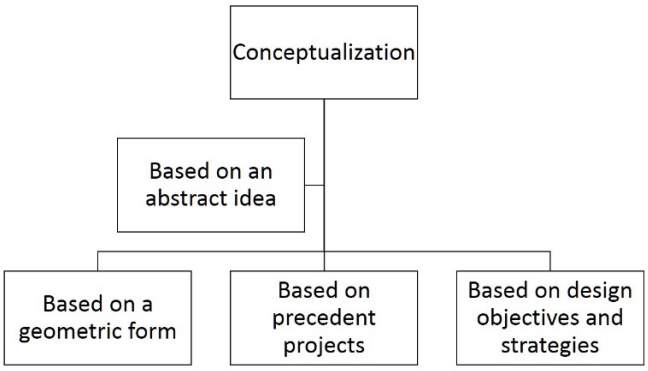


Figure 2: *Bases of the conceptualization in architecture*

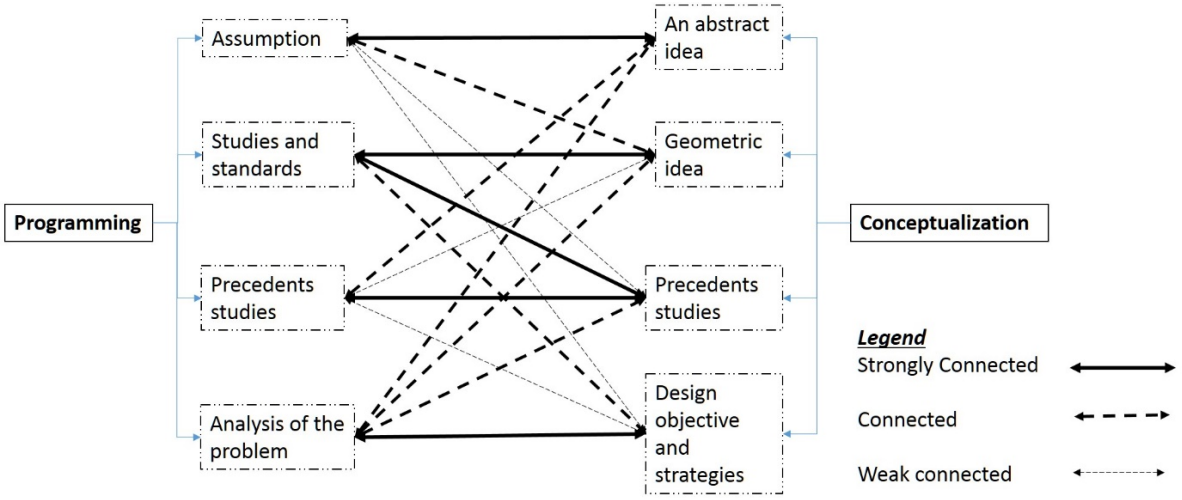


Figure 3: *Relationships between approaches in programming and conceptualization*

Theoretical framework

There are some relationships between the programming and conceptualization in each approach and those approaches are dependent on the applied method, data, analysis, and results. Figure 3 attempts to represent the relationships between programming and conceptualization. The bolded lines refer to the strong connections between approaches in the planning and programming in the conceptualization and the possible selection of the conceptualization approaches although the dashed lines indicate the connections and weak connections respectively. According to Figure 3, the assumption-based in programming is related to the abstract ideas that both of them constructed based on the assumption of the designer. The studies and standards-based approach lead the designer to follow the essential aspects of the design that related to the geometric form (normally basic forms) and the precedents projects that are applied the standards in their projects somehow successfully. The precedent studies-based approach is constructed based on the selection of the composition of the site and projects and so it just could result in precedents projects' ideas for the conceptualization. Seemingly, just analysis of the problem-based approach could

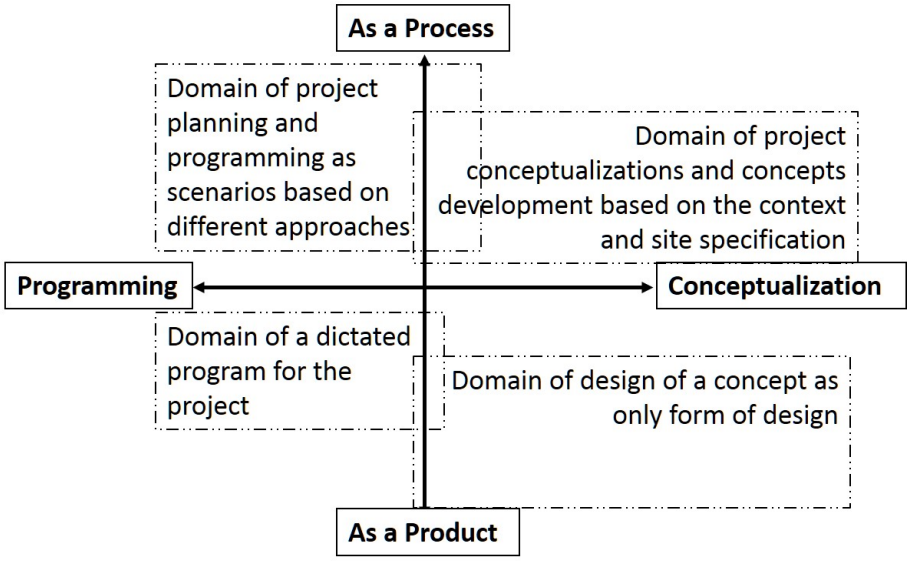


Figure 4: *Domains of the activities in the architecture design*

lead designers to conceptualization based on the design objectives and strategies.

As we explained programming is a process than an event, seemingly the programming and conceptualization have reciprocal interactions. It takes place from different points of view of designers in terms of taking into consideration both programming and conceptualization either as a process or as a final product (figure 4). The programming and conceptualization target the design stage as the final product of the architectural project that the relationships create a specific domain for each of them.

In summary, it is hypothesized that taking into account both programming and conceptualization as a process and problem-solving approach will help the students to develop the architectural thesis project in terms of a design framework for programming-conceptualization.

Methods and Materials

The methods and material of the research included five parts methodology, research design, research process, data specification, and the context of the study.

Methodology

Architecture education research enjoys qualitative, quantitative, and mixed methods research (Franz, 1994; Frayling, 1993; Groat & Wang, 2002; Niezabitowska, 2018) although still there is a movement to avoid these words in architecture studies (Tafahomi, 2022a). The quantitative methods applied to evaluate the perception and points of view of the users in architecture projects and education such as Tafahomi, Xi, and Yang based on the questionnaire and survey of the opinions of the users (Tafahomi, 2021a; 2021d; 2021c; Xi, Yuan, YunQui, & Chiang, 2017; Yang, Becerik-Gerber, & Mino, 2013). Qualitative research was applied to study the architectural problem in the context of projects (Cross, 2005; Gomez, 2003; Norberg-Schulz, 2019), education (Borden & Ray, 2006; Duerk, 1993; Hershberger, 1999; Schon, 1987; Tafahomi, 2021a), graphics (Crowe & Laseau, 2011; Goldschmidt, 2004; Laseau, 2000; Lawson, 2005), and analytical methods (Franz, 1994; Frayling, 1993; Gomez, 2003; Groat & Wang, 2002; Niezabitowska, 2018).

For example, the studies applied content analysis to evaluate the content of the thesis project of the students in architecture programs (Borden & Ray, 2006), analytical texts (Krippendorff, 2003), and architecture projects (Gomez, 2003; Norberg-Schulz, 2019; Mugerauer, 1995). The structure of the analysis was related to the level of interpretation of projects (Drisko & Maschi, 2016). The structure observation was applied to recording and mapping (Regis, 2003; Sperlregen, 2003) the specification of the form (Tafahomi & Nadi, 2021a; 2021b) and function of the built environment (Tafahomi & Nadi, 2020) or behavioral pattern of the users (Bonnes & Bonaiuto, 2002; Tafahomi, 2022b). The graphical analysis was widely applied for the evaluation, assessment, and interpretation of architectural drawing, sketching, and diagraming (Ching F. D., 2015; Crowe & Laseau, 2011; Goldschmidt, 2004; Laseau, 2000; Tafahomi & Nadi, 2021c).

Research Design

This research applied qualitative methods including structured observation, content analysis, and graphical analysis techniques. The content analysis was applied to structure the initial format for programming-conceptualization activities based on both visual and linguistic approaches (Taura & Nagai, 2013). It was supposed that the students could illustrate both textual and graphical information through diagrammatic (White, 1983; Tafahomi & Nadi, 2021c), graphical (Crowe & Laseau, 2011; Laseau, 2000), and drawing outputs (Ching F. D., 2015). In this logic, some textual and diagrammatic matrixes were designed to collect the opinions of the students in relation to the architectural thesis research achievements and design decisions for the programming-conceptualization.

To challenge the normal approach of the students in the conceptualization in terms of "precedents projects" two levels of activities were introduced in the thesis design studio

including programming and conceptualization. It was recommended to fill out a matrix between the architectural issues and actions in terms of relationships between architectural findings in the analysis such as design objectives, strategies, programs, and schematic concepts, and specific issues for actions such as form, functions, site, and context. It was supposed that the students extracted important issues with the architectural thesis projects based on the results of the analysis of data and classified them as architectural findings in the list of issues. The recommended items for the significant architectural issues in the design framework included site, context, character, form, function, technology, and qualities. The logical relationships in the matrix are presented in Table 1.

The site item referred to the site specifications such as topography, orientation, location, and position. The context encompassed the climate, environment, cultural, and social factors that were effective on the design idea of the site. The character exposed the relationships between the architectural project and the contextual factors to make transparent interactions between the projects and the materialization of the idea. The form was discovered through analysis of the different forms through analogous studies to find out the most relevant elements of the design into the programs and concept.

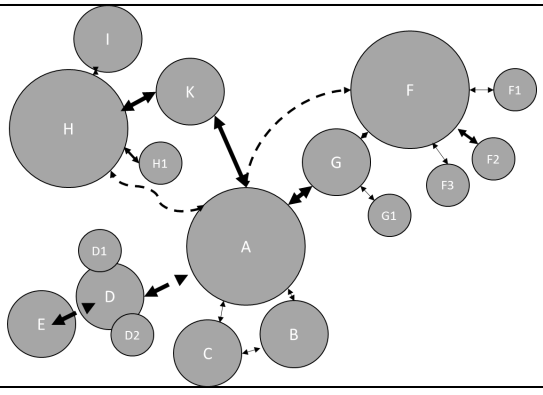
The function arranged the programs for the land, buildings, and the users' activities in both infilled and unfilled areas to clarify the indoor and outdoor relationships. The technology revealed the proposed specific technology and system with the buildings such as cooling, heating, and stability. The qualities in the table revealed the specific quality in the design that the students desired to add to the design such as human scale, natural-based, recyclability, and self-sufficiency.

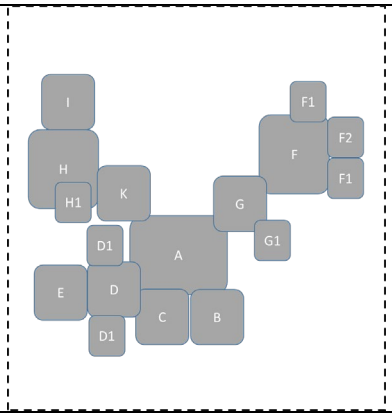
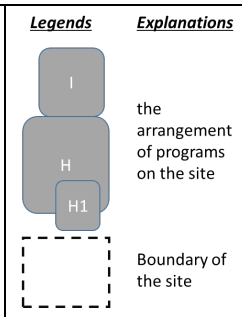
To facilitate the programming processes, the instructor recommended some essential tables to fill out by the students about programs to express the level of privacy, scale, adjacency, and relationships between proposed programs. Table 2 shows tables to facilitate the programming.

Table 1: *The design framework matrix*

Actions Issues	Architectural Findings	Design Objectives	Design Strategies	Outdoor Programming	Indoor Programming	Design concepts
Site						
Context						
Character						
Form						
Function						
Technology						
Qualities						

Table 2: *The programming process based on the tables*

No	Description	Image of the table	The legend of table
1	Table of the scale of programs: It was supposed that the students estimate sizes and scales of the programs for the project due to the site. They could either mark the table or draw a schematic scale for programs to illustrate the variety of scales.	Programs | Small scale | Normal scale | Large scale | Super scale A B C D E F	***Legends*** ***Explanations*** ✓ Symbol for existence * Symbol for non-existence Or graphical diagrams for ***scales*** of each program in the table
2	Table of the level of privacy: The table of differentiation and relationships between the private-public programs was supposed to lead the students to arrange a hierarchy between programs.	Programs | Private | Semi-private | Semi-public | Public A B C D E F	***Legends*** ***Explanations*** ✓ Symbol for existence * Symbol for non-existence Or graphical diagrams for the level of ***privacy*** of each program in the table
3	Table of adjacency It was supposed that the students draw the relationships between programs from adjacent to disconnected.	Programs | A | B | C | D | E | F A B C D E F	***Legends*** ***Explanations*** ✓ Symbol for existence * Symbol for non-existence Or graphical diagrams to illustrate the level of ***adjacency*** programs in the table
4	Conceptual arrangement of programs It was supposed that the students based on achievements in the three mentioned tables arranged the programs to illustrate their spatial relationships.		***Legends*** ***Explanations*** Directly connected Semi-connected Weakly connected Indirectly connected Scales of the programs

5	Arrangement of the programs on the site It was supposed that the students before the conceptualization arrange all the programs on the site to understand the relationships between the programs and the site area.		

It was supposed that the students before the conceptualization arrange all the programs on the site to understand the relationships between the programs and the site area.

After this process, it was supposed that the students start the concept generation based on the sketches they did in the design framework matrix in terms of the conceptual solution for the architectural problems based on the design objective and strategies.

Research Process

The structure of the thesis project was already shared with the students based on the six stages including problem definition and discussion, studies, methodology and research design, data analysis, architectural finding, programming, and conceptual design, which each stage resulted in a specific thesis chapter. Therefore, it was expected that the students already have learnt the essential knowledge not only in the previous year but also through their research in the studies, data collection, and analysis processes. To arrange the research, the researcher presented three lecturers on the programming and conceptualization trends, norms, or styles in the thesis studio to introduce the students to the different approaches. It was requested that the students start to fill the design framework matrix and take into consideration relationships between programs. For those activities, specific workshops were designed to work together on the design framework and the conceptualization activities such as indoor-outdoor, floors, privacy, adjacency, and supportiveness of the programs. According to the shared educational materials, the instructor asked the students to communicate the process of concept generation and development through sequences of reporting, diagramming, or sketching. In the weekly desk-crits (desk critiques), the progress of the students was observed and the essential comments were shared.

Data specification

The data were combined from the designed boards of the students that they presented in the final exam of the thesis conceptualization phase. While there were some specific CATs (Continuous Assessment Testing) on the programming and conceptualization, the data were selected based on the final exam where the students applied all comments, crits, and suggestions to improve the outputs. The data in the boards were graphical data that the students uploaded simultaneously pdf files of the exam boards in the dropbox folder. Therefore, the relevant parts of the exam boards were selected to apply in terms of the data form analysis in this research.

The context of the research

The research took the place in the department of architecture at the University of Rwanda. The department started the program in 2009 based on an eclectic curriculum from another country in the region. The department registered between 25-35 students in each intake yearly and the total number of students is 136 from year 1 to year 5. The ratio of female students is almost close to 15 per cent although each year was different due to the number of registered students. Although the curriculum was designed based on the different styles of teaching in

architecture studios, the lecturers, instructors, and tutors led the program due to their style of learning in the architecture programs. For example, the department experienced clay workshops based on Bauhaus style, painting and graphical courses based on Beaux Art, and precedents projects based on Polytechnique styles of teaching. However, none of those styles continued except precedents study and analysis as the predominated way of teaching in the department.

The architecture program was designed based on five-year studies that the thesis course is served in the final year of study. Each year, the students pass the design studios and theoretical courses importantly, history, theory, and building technology. Both theoretical and practical modules take place in the design studios located on the second floor of the school's building. The design studios include portable chairs, drawing tables, and shelves for archiving the materials without offices for the instructors, divider partitions for students, or a fixed video projector. Place and things are flexible, portable, and changeable.

The students before the thesis studio already passed four years of studies in the department the major part of the learning process took the place in the style of the precedents studies for the design outputs in the studios. Therefore, the students are so familiar with this technique. However, the first semester of the thesis project includes the research and documentation that the students normally take into consideration as a study on the precedent projects than actual research. In this process, both programming and conceptualization also resulted in the selection of some parts of the precedent projects in terms of project and site composition for both programming and conceptualization.

This common way of understanding the thesis project is not the problem of the students but rather the style of teaching architecture in the department. For this reason, both supervisors and juries also look for precedent projects to compare the students' outputs in terms of design boards and ideal projects in programming and conceptualization activities. Apparently, any new style of teaching architecture in this context faces with challenges, disagreement, and misunderstanding. The research took the place in an atmosphere where innovation and creativity of the students not only under the pressure from precedent projects but also application of a new style was not common dialogue for presentation, communication, and interaction of the thesis project outputs.

Results

The students presented their programming and conceptualization in the different styles and boards' arrangements in the both formative and summative exams in the department of architecture, the University of Rwanda. The results were analyzed in two following sections.

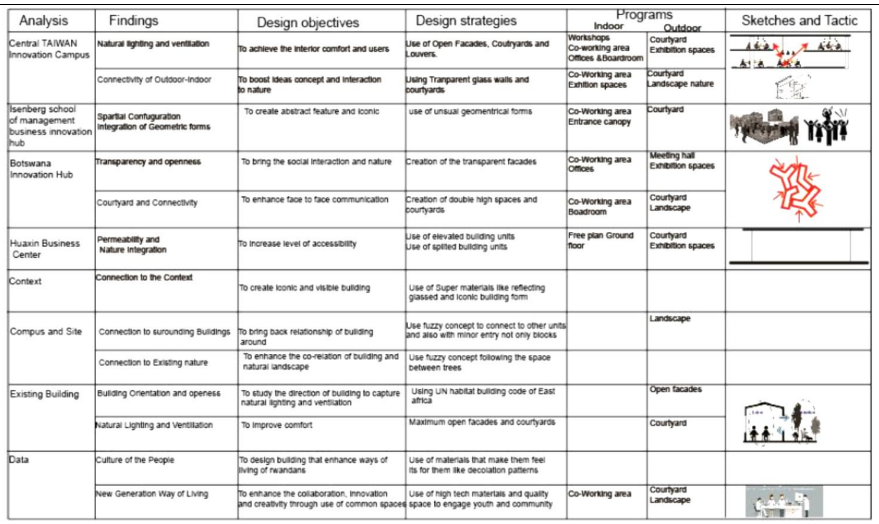
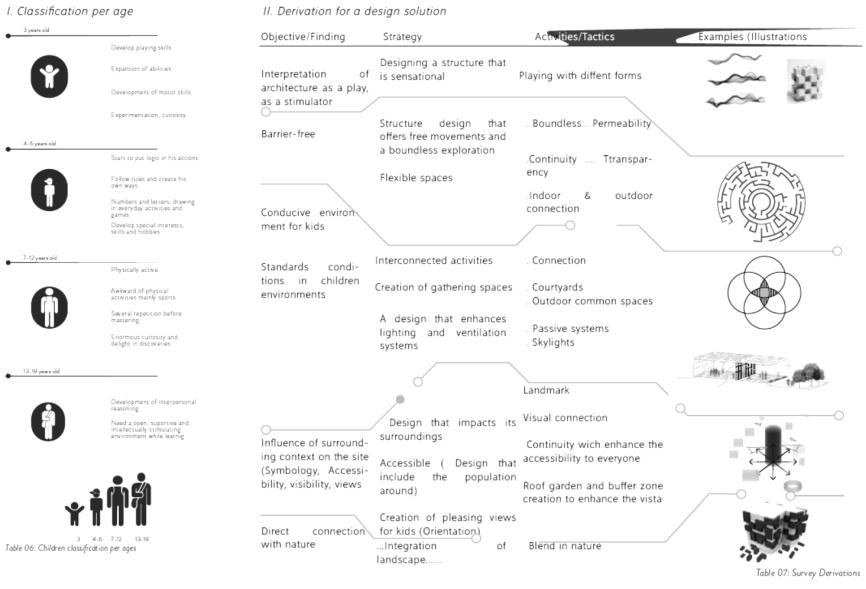
Architecture Programming

The students used the design framework matrix in different ways. The first group of students did not use the design framework matrix and attempted to arrange the programs for the project in a list and different format. They tried to innovate their own structures such as lists, tables, and diagrams to present their own understanding of the exercise. However, the results did not lead them to a logical stage for thoughtful programming and conceptualization. The second group of students used the matrix as an assumption to create their own design structure based on the lessons learnt in the program. Therefore, all applied titles and items were different from the matrix. While there was some similarities with the topics such as design objectives or programming but the logical style of the matrix was changed which did not lead them to present their ideas completely. This group of students understood the design framework as a new task to present their idea for the concept.

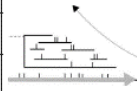
The third group of students followed up on the structure of the matrix and added the analytical achievements in terms of the architectural findings to fill out the design framework matrix. However, this group of students did not apply the achievements in the analysis section it terms of architectural findings to arrange the design framework. Rather, they applied the matrix to arrange new sets of objectives, goals, and

strategies for the thesis project. The fourth group of students applied the matrix in a correct structure although the preliminary concepts of the column of the matrix did not support the achievements. While for this group of students the design objectives and strategies were formulated based on the highlighted problems in the analytical activities, the overlaying of the objectives and the programming and the preliminary concept in terms of the relations between the programs and sketches to solve the problem did not well develop. Finally, the fifth group of students did arrange the design framework matrix and presented the results on the final exam boards. Despite the high number of produced materials by the students, some of the attempts were selected as examples to represent the activities and style of arrangement in Table 3.

Table 3: *Example of attempts to draw design framework*

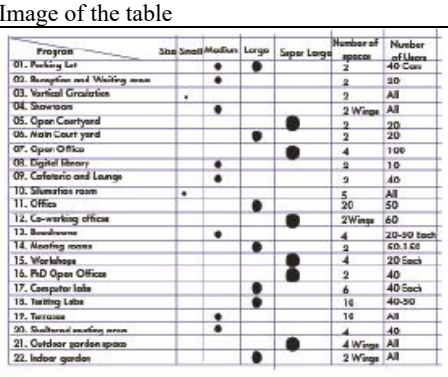
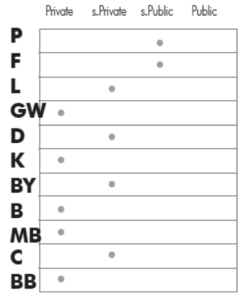
No	Description	Image of the Design Framework
1	**Structure:** columns based on the essential elements of design decisions, and rows based on qualities of design. **Content:** descriptive phrases for decision making **Personalization:** creating clusters of the findings for design decisions based on the architectural findings, and integration of preliminary and detailed sketches for conceptualization.	
2	**Structure:** columns arranged based on the essential elements of design decisions, and rows based on groups of users in terms of target groups. **Content**: applying both descriptive phrases and titles for decision making **Personalization:** arrangement of the design objectives based on the users than findings of the research, and integration of diagrammatic and detailed sketches for conceptualization	

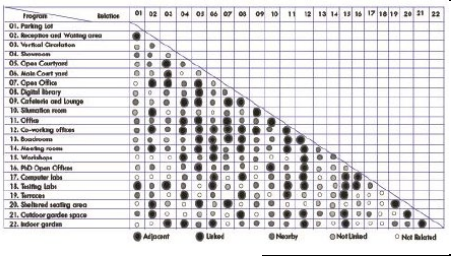
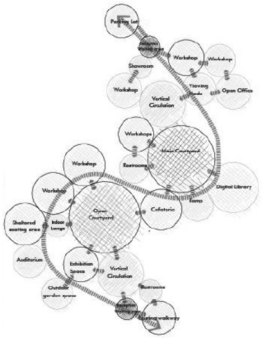
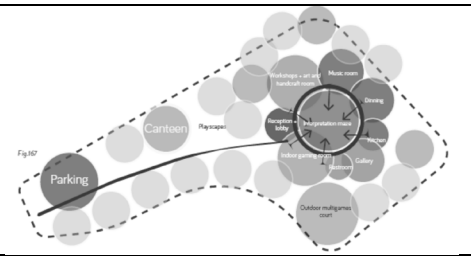
3	**Structure:** columns based on the essential elements of design decisions, and rows based on layers of data analysis **Content:** descriptive phrases and titles for the design decision through programming **Personalization:** applying keywords in terms of the coding system for the programming based on findings and assumptions. Applying detailed redrawing for the illustration of the concept of the design.	

Analysis	Findings	Objectives	Strategies	Programs/ elements Indoor	Oudoor	Tactics/Sketches
Precedents	Different forms/ materials	To achieve spatial diversification	Integration of Primary and irregular forms	each program	Fauntain	
	Transparecy & Feeling exposed	Indoor/ Outdoor connection	Maximizing openess	Retail shops Market hall	Kiosk Retail space	
	Connection of spaces through open floor plan	To achieve collaboration	Double High spaces & Mezanine	Market hall wholesale shops		
Context	Views to mountains /Mt Kigali & Mt Jali	To create strong Indoor /Outdoor connection	Maximizing views through the design	Restaurant and caferia	Playground	
site	Social Interaction	To create interaction hotspot	Open space for MOB events	Cinema	Parking Garden	
	Slope integration	To blend into contours	Limeted Excation	Cinema	Sitting platform Garden	
	Wind /solar orientation	To achieve Interior comfort through protecting East-West	Use Cross/stack ventilation Sun screening material	Service area		
Data	80 % of users said existing spaces are not exposed to clients	To design exposed &transparent space	Playing with Variety in material/ form,...	Retail shops Market hall	Kiosk	
	72 % of users need a a common spaces	To achieve collaboration	Creating courtyards / squares	Restaurant/ Market hall	Kiosk	
	Promoters want Identity of Rwanda in Design	To fit Into context	using Local materials/	Restaurant/ Market hall	square	

In the relationships between the programs, functions and activities, it was supposed that the students used tables and diagrams to represent the relationships. The students presented their diagrams in the five approaches without diagram, with private-public matrix, with adjacency matrix, without fitting into the site, and fitted into the site that the results illustrated in Table 4.

Table 4: *Sample of application of the program's relationships by the students*

No	Description	Image of the table	Elements in the diagrams
1	The scale of programs: the table was arranged based on the bubble diagrams to show the scale of the programs and detailed columns were used to indicate the number of programs and floor addresses to present arrangement in the buildings.		List of programs Bubble maps for sizes Number of programs Addresses of programs in the floors
2	The level of privacy: The student marked the table to categorize the level of privacy.		List of program Marks

3	Table of adjacency The table was arranged based on the relationships between the program to show the level of adjacency with some titles such as adjacent, linked, nearby, not linked, and not related.		List of program List of specification Symbols for specification A personalized heiarchy for the adjacency of programs
4	Conceptual arrangement of programs The students arranged the program in a conceptual relationship to present the program based on the outdoor and indoor activities. Extra graphical lines were applied to link programs and users.		Bubble figures for the arrangement of the programs Scale of bubble to illustrate size of the programs Hatch as a symbol to show priorities Use of lines as the main connections between of programs
5	Arrangement of the programs on the site The students used the bubble diagram to illustrate the areas of the programs and the adjacencies on the site. While the arrangement was clear, open spaces did less covered by the programs.		Bubble diagrams Title of diagrams Size of program Line of connection Relationships between programs

The first group of students preferred to slip from the task and continue their own conceptualization by diagraming the programs to avoid any wasting time. The second group of students provided a table to evaluate the specification of the program due to the level of private-public specifications and attempted to make a logic for the program arrangement in the diagram. The third group of students not only provided the private-public diagram but also added the adjacency and supportiveness diagram as an achievement for the programming in the appropriate way. The fourth group in addition to the third group attempted to represent the relationships between the programs in some spatial diagrams but in an abstract way to discover interactions between programs. The fifth group of students brought the programs and diagrams into site-map to evaluate how the programs fitted well into the structure of the landform.

Conceptual Design

In the conceptualization stage, the students performed in the four categorical types including precedents projects, geometric, programming diagrams, and concepts in the design framework matrix. The first group of students according to the lessons learnt in previous years of studies in the program used precedent projects as sources of conceptualization to modify the forms into a new concept for the architectural thesis project. They applied both form and function of the precedent projects in two ways. First, they modify the forms as personalization and assimilation of the architecture knowledge into a new form that was common for many years in architecture schools. Second, they integrated the forms and function in terms of composition in the design process. The second group of students used geometric shapes to generate concepts for the architectural project. A significant part of the students used rectangular forms to form the concept for the programs and the project due to static measures. While the

students applied some geometrical forms such as squares, triangles, and combinations.

The third group of students applied the programming diagrams for the conceptualization particularly the arrangement of the programs due to adjacency. This approach for concept generation also led them to the geometric forms for the plan arrangement. While this group of students developed the concept to a more proper level such as facade and material, the composition of the programming and adjacency was predominated aspects of the conceptualization. Importantly, this group of students lost the opportunity to see the project as a united form between indoor and outdoor. For this reason, the relationships between the site and building (s) were weak. Fourth groups of the students followed the design framework at the first attempt or through desk-crits they returned back to generate the concept based on the preliminary sketches in the design framework column. This group of students had a process of concept generation through different sketches in the design framework matrix that made them rich in the generation, integration, and development of the concept. The concept included various aspects of the site, context, form, and functionality of the projects.

The Research Findings

The results of the research highlight five categorical aspects in the exercise that was common among the students to apply the design framework matrix. These findings include problem-solving approach, relationships between the programs, personalization of the matrix, inspiration for concept generation, and finally weaknesses of the application.

One of the continuous topics in architecture education is problem solving and the link between the problem definition and problem solving in the architectural design process. Apparently, the arrangement of the matrix is in the way to link the architecture problems and architecture findings. The creation of a link between data, methods, analysis, and design objectives and strategies is a successful result that reminded the students how to take decisions for problem solving through programming and conceptualization. This organization of design decisions based on the architectural findings, design objective and strategies construct a forward-backward action between the stage of programming- conceptualization and research activities in the architectural thesis project. The students demonstrate awareness of problem-solving activities through the design framework. While there is a small group of students that prefers to apply their own ideas for programming-conceptualization than a process, the achievement of the design framework links the architectural findings and the design proposal.

The design framework highlights the relationship between all processes, stages, and activities. The design framework links all the activities in a matrix in terms of relationships. In detail, there are three relations in the design framework between programs, concept, and site. The detailed tables of the adjacency, private-public, and size of the programs lead the students to arrange the programs in a more proper way than a personal assumption. While the structure of architectural education is normally arranged based on design outputs in terms of design product, the process of learning is so important to build a logical foundation in the mind of the students. In addition, the programming process leads the students to fit the programs not only with the internal connections but also with the form of the site. This process of programming-conceptualization on the site leads the students to pay more attention to relationships between indoor-outdoor programs and activities on the site to find out the appropriate arrangements and alternatives. The diagrammatic arrangement of the programs on the site gives the students a general inspiration to find suitable forms for the next step of concept generation and development.

In detail, concept generation is a tough task for the students to select among many sources and alternatives. While it is common to see the students prefer to start with geometric from or precedents projects, the programming-conceptualization leads them to put all the

programs on the site and see the relationships in diagrammatic performance. This exercise helped the students to discover the appropriate form from the inside of the site than outside, from real relationships than assumptions, and the real form of the site than an abstract geometric. In fact, programming-conceptualization through diagramming creates an alternative to add to the other scenarios for the conceptualization commonly geometric, precedents studies, and abstract.

While the design framework includes a structure, the students personalize both structure and content of the matrix to innovate their own way of presentation, communication, and interaction of programming-conceptualization logic and proposal. The major part of the personalization takes place in the arrangement of the rows of the table based on their own way of understanding the processes, priorities, and importance of programming-conceptualization. For some of the students the quality of the design is important that they learnt in the theory and building technology. However, some of the students prefer to take into consideration users of the project. It is a great achievement for the students to pay more attention to the client and the final users of the project. Therefore, this activity could call in terms of the user-oriented design concept by the students. Another group of students applies directly the topic of the analysis activities as a driving factor to formulate the design objectives, strategies, and programming-conceptualization. This direct connection creates a clear link between the architectural problems definition and design solutions. Perhaps, both similarity and dissimilarity could be presented through comparison between two words of architectural analysis-driven and architecture findings-driven. Apparently, the architectural findings-driven is a higher level of an analytical approach to deal with programming-conceptualization activities.

The results of the analysis highlight that the design framework includes some weaknesses. First, this process of programming-conceptualization was started to dialogue in 1970-1980 to transparent the programming and conceptualization process, particularly for architects, artists, and design students. Therefore, the major part of the activities was designed based on freehand drawing, sketching and diagramming. For the students who are engaged from the first year of studies with computer software, the application of mind-hand activities is a difficult task, particularly; when they expect that software do all activities for them. Second, such kind of techniques is developed based on the environmental and psychological research activities that were advocated in the 1980-decade filling the gap of the self-driven design activities with more research-based activities. Therefore, for the students who are engaged in the in-studio learning activities based on the Polytechnique style of education, the application of the alternative in the final year is a revolution in the learning process and many of them prefer to continue in the same way as previous years. Third, to harmonize evaluating the quality of the students' products and design outputs through a design framework needs many guidelines for the supervisors, juries, and evaluators to construct similarities in the understanding of the task, process, and outputs that require time, passion, and system to achieve an effective result.

Discussion

The findings of the research underlined that the creation of educational processes for the training and educating of architecture students was a new generation of methods and approaches that took into account the modern time. While methods of education in architecture schools were constructed based on the training of the students through an apprenticeships tradition (Draper, 1977; Drexler, 1975; Garric, 2017), the modern style of education attempted to open the door for new ideas for the teaching and learning of architecture (Boradkar, 2010; Gropius, 1970; Marttila, 2018). In this logic, educational methods looked forward to inclusiveness for everyone based on the process than an event (White, 1975; 1983; Pahl, Beitz, Feldhusen, & Grote, 2007). Programming-conceptualization was documented recently as a new style of

teaching and learning in engineering, art and architecture (Cross, 2005; Borden & Ray, 2006; Pahl, Beitz, Feldhusen, & Grote, 2007; Pena & Parshall, 2012) to decode the design process as Lawson attempted to draw the process (Lawson, 2005). The bulk of studies analyzed the conceptualization process in different states or phases between the mind of the designer and the illustration of the idea that a major part of the studies at least agreed on two stages including planning and conceptualizing (Pahl, Beitz, Feldhusen, & Grote, 2007; Taura & Nagai, 2013). This progress of illustration of the design process based on programming-conceptualization took place in a scientific approach in the opposite of tradition advocated, "we teach as we have been taught" (Tafahomi, 2022a).

The findings of the research revealed that the design framework model had an effective role to connect architectural problems, architectural findings based on analysis, and programming in terms of problem solving in the architectural thesis studio. This activity created a process for the programming-conceptualization than an event that White illustrated the process profoundly (White, 1975; 1983). This achievement was advocated by studies in terms of the qualities of the architecture thesis projects (Borden & Ray, 2006; Ghonim & Eweda, 2019). While the studies challenged the architectural style of design in terms of ill-structured problems and answered the problem as a paradoxical approach to the design (Simon, 1973; Dorst, 2006), the design framework proposal attempted to draw a scaffold to align the fundamental activities in the thesis process in terms of a framework.

While programming in architecture was constructed based on the composition style through studies of the great architecture buildings importantly Roman style (Draper, 1977; Drexler, 1975; Garric, 2017; Littmann, 2000; Madanovic, 2018; Tafahomi, 2021a; 2022a), the new approach of education recommended documentation, analysis, and alternative based on a scientific process (Goldschmidt, 2004; Lang, 1987; Taura & Nagai, 2013; White, 1975; 1983). The findings of research highlighted that application of programming activity in architecture education led the students to apply alternative approaches for programming activities from the step of assumption about programs to analytical and comparative stages similar to the finding of the methodological studies (Borden & Ray, 2006; Franz, 1994; Groat & Wang, 2002). The students applied five clusters of relationships in the programming including size-scale, private-public, adjacency between programs, and the site. These activities were designed based on processes of programming that let the students think deeply, revise continuously, and arrange alternatively. This achievement was in the same direction as Gropius in terms of a new alternative to architecture education (Gropius, 1970). In addition, the results were supported by the visual and linguistic presentation of the concepts (Taura & Nagai, 2013), display clearly the design objectives (Goldschmidt, 2004), decoding of the design process (Lawson, 2005), application of methods for programming (Tafahomi, 2022a), and changing an unmodern style of architecture education (Garric, 2017).

The exercise illustrated that the students obtained the idea for concept generation through the programming process. This finding challenged the idea of the concept as an event. In fact, the students through forward-backward activities in the programming-conceptualization attempted not only to get ideas as inspiration for the architectural concept in the thesis studio but also they evaluated the concept due to the design objectives and strategies in terms of design decisions. While this process was similar to White ideas (White, 1975; 1983), the achievement of the exercise supported the theory of active archiving of the designers' mind (Lawson, 2005), designing a process to eliminate all obstacles (Gropius, 1970), and an alternative way in architecture education (Marttila, 2018). The students took distance from the precedent projects toward attention to the site, context, and users in terms of the missing aspects of research in architecture that were discussed widely by studies (Franz, 1994; Groat & Wang, 2002; Hershberger, 1999; Niezabitowska, 2018; RIBA, 2014; Tafahomi, 2022a).

The students did not follow the proposed structure and they added some innovations and creativities to personalize the design framework. This flexibility of the matrix revealed that the students constructed their own way to apply the design framework in the programming-conceptualization activities in terms of accumulation of knowledge than assimilation (Tafahomi, 2021d). It was the target of the education in terms of a personal journey in learning activities (Tafahomi, 2021a) to enhance the quality of the thesis projects in architecture (Borden & Ray, 2006; Ghonim & Eweda, 2019). This activity allowed the students to apply, change, and redesign the design framework as their understanding of the exercise in terms of multiple approaches to the design (Boradkar, 2010). The personalization process of the design framework led the students to fit different ideas of the design through an innovative and creative approach which was disused widely in both engineering and architecture education (Borden & Ray, 2006; Cross, 2005; Crowe & Laseau, 2011; Ghonim & Eweda, 2019; Pahl, Beitz, Feldhusen, & Grote, 2007; Taura & Nagai, 2013).

Conclusion

Architecture, architects, and architecture education are under the regeneration process due to the development of new areas of knowledge. No one sees architecture projects, processes, forms, functions, and meanings as they were in the last century even one decade before. They are part of our history, context, and achievement. However, their time passed. They are regenerated into new forms, they are criticized for their mistakes and dysfunctionalities, they are challenged by new technology, and they are evaluated by users. Apparently, this transformation of architectural projects is an essential characteristic of the architecture profession. In the same way, architectural education also needs to be flexible due to time and space. Despite the long history of architecture education in any parts of the world, the western model of architectural education has been the predominated model in many institutions across the world that now it needs to take into account as a contextual topic.

The design framework is a logical matrix that leads students to link the architectural problem, architectural findings based on the analysis, and architectural problem solving through systematic design decisions for design objectives, design strategies, and programming-conceptualization. Despite the difficulties to apply the matrix by some of the students, whole participants in the thesis design studio applied the design framework in a personal way of learning as a new educational approach. The results of the application of the design framework in the thesis module reveal that the students innovate their own way to adapt, interpreting, and applying the educational approach into practice. Therefore, the students perceive the design framework as a rough material that needs to be manipulated in a personalized way in the specific themes and topics of thesis projects.

The logical process between the architecture task and the design objective and strategies is a crucial topic that needs to be planted in the earlier years of the architecture studies and look at this process as an approach than applying it just in the final year of study. Architecture education needs to be more inclusive in relation to approaches in education although there are some schools that preferred to be more orthodox than avant-garde. While the matter of education is not a style, rather than it is a scientific field that needs to take into account professionally. All fields of science and knowledge are going toward multidisciplinary and interdisciplinary approaches. Bringing a new approach to an architecture design studio to test the effects, results, and outputs is a quite comprehensive way to understand architecture in the current time and space.

The design framework includes some deficiencies as other techniques have. For example, the process of programming and diagramming is difficult for the students, particularly for those who apply CAD (computer aid device) software in every stage of design. For those students, the concept starts from an actual plan, section, and materials as the software do the design for them. This replacing the computer with the hand drawing

is dependent on the software for the logical relationships between programming-conceptualization that such kind of artificial intelligence will perhaps generate in future. While the students who apply graphical software to represent and redraw the programming process for the logical presentation, they seemingly, still need to make a balance between the sketchbook development and the application of software in architecture schools.

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