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Towards a Process-based Model for Teaching Architectural Design, with Reference to Design Studio One*

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The design studio often lies at the very heart of architectural education, being the pool in which the outcome of all other courses may holistically synthesise. In early educational studios, particular attention needs to be paid to the limited design experience that students may have already acquired, together with the amount of information they need to process within strict academic timeframes. This should also develop within an appropriate understanding and carrying-out of design as an integral, systematic and logical process. Thus, the present study primarily aims at developing a process-based approach to teaching 'architectural design I' that responds to the aforementioned challenges. The proposed model is described in two phases. The first phase comprises six steps that are planned as a medium for gradual and cumulative learning about the principles of architectural design. The second phase comes in four steps. It aims at introducing students to a systematic design process that they can pursue in their future academic and practical endeavours. The proposed model should help students to grasp the basic interdependent design principles, apply them within a systematic logical process, and gain independence in future design studies and professional development.

Keywords: engineering education; architectural design; design process; design principles

1. Introduction

For many architectural educationalists, architectural design is seen as the central point of the architectural curriculum. This belief partly emerges from the special nature of architectural design as an extended medium that requires the simultaneous application of several acquired experiences holistically. Such experiences include: drawing skills, literary analogies, structural stability, climatic appropriateness, human comfort, and many more. Therefore, the teaching of architectural design has been the focus of many extended debates and academic research around the world. This makes the exchange of pedagogical practices in this field particularly significant to the development of academic and professional fields in architecture.

When it comes to 'design studio one', it is common that many students begin their architectural education with very limited design experience. In their early design endeavours, students need to realise a vast spectrum of interrelated and interdependent principles simultaneously. They may not even know how to design . . . what to design . . . or what makes a design good. Such challenging complexity has overwhelmed and disoriented many students in their early design steps.

Therefore, particular attention needs to be paid to the amount of information that they receive within a strict academic timeframe, particularly with their limited design experience. This should also develop within an appropriate understanding and undertaking of design as an integral, systematic and logical process.

However, it is important for the useful exchange of academic experiences to be driven through channels of observable and replicable mechanisms, i.e. in terms of a sequence of distinctly identifiable activities, which occur in logical order. This can promote future examination and development of these experiences.

Therefore, the present paper introduces a process-based approach to teaching 'architectural design I' [that is the course taught in 'design studio one'] to respond to the aforementioned challenges. The proposed model is described in *two phases*. The first phase comprises six steps that are planned as a medium for *gradual and cumulative learning* about the principles of architectural design. The second four-step phase aims at introducing students to a *systematic design process,* which they can pursue in their future academic and practical challenges.

2. Background

This model has been regularly applied and constantly developed since Spring 2007 with 'Architectural Design I' students in the Department of Architectural Engineering and Environmental Design, Arab Academy for Science, Technology and Maritime Transport in Cairo, Egypt.

AASTMT students undertake the 'Architectural Design I' course in their fourth academic semester. The core architectural courses that they attend

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beforehand are 'History and Theories of Architecture', 'Visual Studies', 'Building Technology' and 'Architectural Drawing'. The nature, content and emphases of these courses partly explain the limited 'design' backgrounds that students may have at this point.

'Architectural Design I' primarily aims at introducing students to the principles of architectural design at a basic level. These principles include: function and circulation; geometric relationships and aesthetic proportions; desirable orientation and climatic treatments; natural lighting and ventilation; spatial qualities and structural stability; site constraints and contextual regards; facade compositions and cross-sectional potentials—all at their very elementary level, yet in three-dimensional interrelation and holistic integrity.

Towards the above objective, students are introduced to these principles through *small-scale projects* that they can handle at their early steps. This kind of pedagogy is related to '*learning by doing*'. It is very common in architectural curricula and design studios [1, 2]. In this regard, Nabih [3] stresses that *simplified architectural problems* are more appropriate for junior students to better identify constraints and develop solutions.

An academic semester typically lasts for sixteen weeks. Eight studio-hours are conducted on two different days every week. The staff/student ratio is one to seven, which compares to the one to eight ratio identified by Tapper [4] for quality performance in American universities.

Studio tutoring is generally carried out through whole-studio lecturing, small-group tutorials, tutor/peer reviews, and individual critiques. Frequent research tasks and oral presentations take place to improve students' self-learning and communication faculties. In such presentations, external faculty members may be invited to provoke extended debates and engage in critical discussions about students' work.

Nabih [3] argued for involving theoretical *lecturing* in design education, to enable students to integrate theoretical concepts within their design assignments. Lectures additionally provide a medium for informal discussions and critical examination of ideas in a fashion that complements the role of other adopted teaching methods. By integrating theoretical concepts in design projects, more diverse design solutions can be produced [3, 5, 6].

On another hand, *small-group* problem-solving activities help students to develop a variety of solutions for a single problem, and promote students' collaboration to learn, negotiate and make collective decisions. It also provides an opportunity for students to gain analytical review for their work, take challenges in a critical yet supportive environment (colleagues and tutors), and improve their faculties to criticise their own work [7, 5].

Last, but not least, the *one-to-one* critiques are the optimal medium for handling individual difficulties and specific design problems with hands-on problem-solving experience.

3. Problem definition

Despite the limited design experience explained above, junior architecture students need to realise a vast spectrum of interrelated and interdependent design principles. Flooding them with sizable amounts of information at once can be seriously problematic to their attainment. In such cases, students may become seriously overwhelmed and disoriented.

On the other hand, dividing up these interrelated principles may hinder a student's ability to grasp their integrity, and how they could fit together within a systematic design process.

Nevertheless, it should be borne in mind that these beginner students may have never been through an entire systematic design process. So a route must be planned for them to learn about the systematic phases of the design process, hence enabling them to use them in their future academic and practical work.

Therefore, the present study is primarily meant to develop a teaching method for students in 'Architectural Design I', which deals with two principal forces, namely:

(1) regulating the amount of information that is delivered to students into reasonably attainable chunks that are not too fragmented to overlook their interdependence and interrelationships;
(2) undertaking an entire systematic design process in order to grasp the sequence and relationships between its phases.

3.1 Information overload

It is fairly natural that people get troubled, to different extents, when they are swamped with large amounts of information in a short span of time. Previous studies confirmed that the amount of information that an individual can receive, process and remember is limited [8]. Information overload was found to be a stress-making factor that may lead to different kinds of disorders [9, 10].

Information overload is generally defined as too much information offered within a short time, in a way that is difficult to comprehend and process. It occurs when the amount of information received is more than one's capacity to process it gainfully and meaningfully, especially if the nature of the information is unspecific, vague, new, complicated or compressed (as in the case of complex design principles) [11, 12].

However, it was as early as the third or fourth century BC, when information overload started to be recognised and disapproved [13]. Tzeng's [14] study of undergraduate students confirmed that the amount of information was quite critical in brain storage phases, not to mention processing and recalling. Ruff [15] further depicted information overload to be as problematic as the lack of information, particularly in terms of decision making and problem solving.

As stated above, the design studio is the medium in which the outcome of all courses may come together, be it history and theories of architecture, architectural drawing and presentation, physical and digital modelling, theories of structure and building materials, or even basic high-school geometry. It is the combination of all courses in architectural education [16–20].

Design is generally known to be unclear to students, as it is about the rapid learning of something that does not as yet exist. This kind of learning can be better approached by exploring the *interdependencies* of problems and solutions [3, 21].

Therefore, Nabih [3] suggests that junior architecture students be trained to respond to a *limited number of clearly identifiable design constraints*, in order to be able to develop more plausible solutions.

It is clear from the above discussion that the amount of information and the magnitude of the complexity in the 'Architectural Design I' course requirements firmly call for the setting of an appropriate framework to lead to their effective accomplishment. Such a framework should necessarily regulate the amount of information delivered per class, to avoid any undesirable influences that may be associated with information overload. However, it should ensure that students are aware of the holistic and integral interrelations between all design principles and components.

3.2 Design process

The design process involves multiple activities, i.e. problem definition, analyses, syntheses, realising solutions and post-solution assessment [22]. On the other hand, Bruce Archer's prominent 'operational model' described creative problem-solving process as encompassing programming, data collection, analyses, syntheses, development and communication. Most importantly, he introduced the idea of feedback loops to bridge any gaps and cover any shortcomings in precedent phases of the model [23].

Such complexity and multi-dimensionality requires a holistic approach to the design process, where the concern is with the whole, rather than separation into fragmented parts [40].

Therefore, it is particularly important to devise appropriate means for students to be able to integrate all design elements and phases within a logically appropriate framework, which appreciates the very holistic nature of design. For that purpose, a *two-phase model* is proposed here, to be undertaken for teaching 'Architectural Design I'.

The forthcoming discussion is based on the behaviourist approach to creative problem solving, which advocates that problem-solving processes can be adequately explained in *observable measurable and replicable* patterns of physical behaviour [23]. This should allow one to describe the proposed model in terms of a sequence of distinctly identifiable activities, which occur in a predictable and identifiable logical order, as suggested by Lawson [24]. In addition to its value to the present study, it supports Nabih's [3] argument that students need to be aware of the individual design phases and address them with a holistic design reaction.

4. The proposed process

Akalin and Sezal [25] suggest that the practice of architectural design is traditionally learned through a *'project-based'* studio approach. Cunningham [26, p. 433] further quotes 'Project-based education around architecture employing the studio system is the most advanced method of teaching complex problem solving that exists'. This complies with Dewey's [27] 'experiential learning' philosophy that emphasises experience, experiment, and purposeful learning towards the acquisition of cumulative knowledge. It is also a reflection to 'learning by doing' pedagogy outlined earlier in this article [1, 2].

As a project-based approach, this model introduces students to two consecutive phases throughout the academic term, which involve students in a guided exploration of the design principles and processes.

The first phase employs a residential project aiming at the *gradual revelation and cumulative attainment* of the required design principles. This is believed to eliminate the overwhelming influences that students may experience due to the magnitude and complexity of the studied material.

By the end of the first phase, students would have already known about the required design principles. In the subsequent phase, a second project introduces them to a *systematic design process* that they can pursue in their forthcoming design experiences.

4.1 Phase One

As mentioned above, this phase is meant to facilitate a medium for students to gradually and cumulatively learn about the required design principles. It is composed of the following steps:

- Step I: Given plan [a. functional and spatial requirements, b. technical and aesthetic proportions]
- Step II: The site [a. outdoor constraints, b. indoor constraints]
- Step III: Structural system
- Step IV: Three-dimensional modelling
- Step V: Developing architectural projections [elevations and sections]
- Step VI: Final presentation

The following discussion explains in detail the objectives, procedures and outcomes for each step.

Step I: Given Plan

Ochsner [28, p. 195] quotes:

> For a beginning student, the design studio process can be *mystifying*; indeed, it may not be very clear what the instructor expects the student to do. But, the instructor cannot really *explain* until the student has already *begun*. . . . the instructor cannot really enter a *dialogue* with the student until the student has *generated an initial response* to the problem, *creating a basis for the dialogue to begin* . . . it is a *gradual process of discovery that is often best* approached . . . and it cannot even be explained to beginners, but still *requires a beginning before the instructor can offer assistance*. [Author's emphases]

Therefore, the present model aims at starting with such a '*beginning*', in order to facilitate more efficient interaction between instructors and students. This sets the required starting point for the gradual learning of the multiple interdependent architectural principles that students are required to master.

In order to follow the proposed gradual revelation/cumulative learning model, students are first given a residential plan, which encompasses a few intentional shortcomings. Students are assigned to draw this given plan to refresh their architectural drawing experience, which they have developed in the previous academic term. This phase is covered in one class and involves minor design-decisions such as door/window type, position and width.

a. Functional and spatial requirements

In line with Tschumi's [29] ideas that architecture is about mutual interaction between *space* and its *use*, students are lectured about spatial and functional requirements for furnishing residential spaces in accordance with user needs. They are then asked to furnish the *given plan*, to start finding any of its inappropriate spatial settings, in relation to sound furniture and proper functioning. For a whole week, they are required to modify the physical dimensions of the given spaces, so that they better-fit the proposed furniture requirements. This is when the students' projects first start to differ from one another.

b. Technical and aesthetic proportions

Having transformed the dimensions above, students are taught about convenient proportions and geometric relations in the plan. This focuses on the aesthetic proportions of the resulting spaces, as well as the technical aspects influencing wall bonding, material connections, construction limitations, etc. Students are thus assigned to develop their plans once more, while maintaining the spatial qualities that they have achieved earlier for functional requirements.

The main outcome of this step can be accomplished in one study week, partly overlapping with the preceding step. It is mainly described as the knowledge of spatial requirements for appropriate functionality, as well as the sound proportions and technical relations in the plan.

An added virtue of starting with such a 'beginning' is to overcome the common student misconception of design as a mere process of producing plans, paying little attention to the holistic nature of design, which deals with the three-dimensional physicality, as well as the subjective aspects of symbolism and the user's individuality. This procedure sub-consciously confirms to students that having a plan in hand is by no means a near-end stage of the design process. This will be much clearer after the discussion of the following steps in 'Phase One', as well as those of 'Phase Two', below.

Step II: The Site

Without a *real site*, we cannot talk about *real architecture* [30]. Architecture thus provides the real presence of a building on the site. It is on- site where the building acquires its necessary uniqueness. It is on-site where the specificity of architecture becomes realised and understood [31].

Therefore, the subsequent phase is site planning, in which students are informed about the designated plot dimensions, north direction, and surrounding context. This is usually meant to be chosen in a sense that creates problems with building dimensions, elements orientation and entrance location. Accordingly, the students will have to handle two main types of design problems in this step, namely indoor and outdoor problems.

a. Outdoor constraints

At this point, students are introduced to basic landscape elements, vehicular and pedestrian movements, and vegetation and water features. This is done on a very basic scale that suits the project requirements and the students' early stage of development. Students also learn about the significance of context, how to respect it and how to make use of its potentials, in terms of access, visibility and privacy.

In terms of the assigned exercise, students may have to alter building dimensions and alignment in relation to street/entrance relationships, favourable views, pedestrian/vehicular pathways and pool/ fountain locations.

b. Indoor constraints

In parallel with the above, students are introduced to the optimal orientations for natural lighting and ventilation, with respect to different functional elements. For this purpose, sun path diagrams and desirable/undesirable prevailing wind directions are briefly discussed, together with the appropriate fenestration proportions and treatments for every direction.

Having relocated the entrance in response to outdoor constraints, other interior elements will also have to be relocated, whether in response to change in entrance, or as a consequence of inappropriate orientation. This predominantly comes in relation to wind direction desirability, a priority for favourable views or direct sunlight exposure (e.g. living area vs. view, bedrooms vs. sunrise, kitchens and bathrooms vs. wind direction/undesirable odours . . .).

Yet, all indoor changes take into account the organisation of furniture together with the spatial and proportional qualities. Coordination between layout and architectural plans remains constant throughout all development endeavours, in order to promote a healthy accumulation of acquired experiences.

In brief, the outcome of this step comes in three to four classes (i.e. $1\frac{1}{2}$ to 2 weeks) to reflect knowledge about orientation preferences in regard to elements distribution (wind, light, view, access), site organisation (vehicular and pedestrian movement, vegetation and water features), and appropriate architectural relationships with site and context constraints.

Step III: Structural System

This step introduces students to one of the simplest structural system, i.e. *post and beam*. When they start positioning posts, they find some problems that will require architectural and spatial adjustments. They are introduced to the system in one session to start development, and then they receive feedback in the following class. This step concludes with proposed architectural amendments towards accomplishing sound functional and structural utility. The role of structural elements in space definition is also taken into account.

Here students are also required to maintain constant coordination between layout and architectural plans parallel with any introduced amendments throughout this step.

Step IV: Three-dimensional Modelling

Akalin and Sezal [25] argue for modelling and design to be intimately linked, that design can be the *articulation of ideas* in modelled formats. It can be used to communicate a designer's thinking or imaging *to oneself* and to others [32].

Through modelling, students can test hypotheses, judge validity, stimulate thinking and enrich their imaginative faculties [6, 25, 33]. It can encourage self-reflection and design refinement by appraising, prioritising, evaluating and consideration of all design constraints [34]. Therefore, modelling can evidently have a significant impact upon students' creativity in design problem solving.

By producing the site plans, and the modified elemental organisation of floor plans (in accordance with site constraints and structural requirements), students have not yet thought of their building height, and how it may look for an outside-viewer. Therefore, they start here to produce simple study-models to examine and develop their masses in the three dimensions.

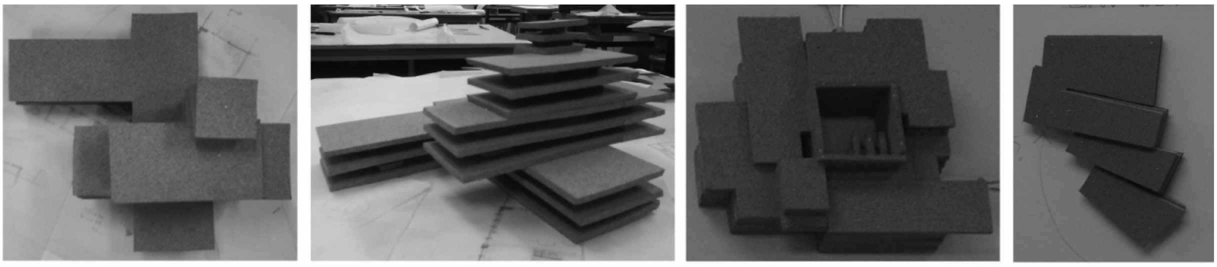
These study-models are usually made of 5 mm-thick cork layers that are fixed together with pins, in order to allow for modification and development. Usually, the first product is more of a box-like object, which they get to improve by *changing heights, rotating parts and introducing extrusions and recesses* to the proposed masses. In theoretical terms, this is about dimensional, additive and/or subtractive transformation, as well as the three-dimensional rotation.

Again, the students are constantly advised to keep an eye on their floor plans and site plans while developing these models, to emphasise their interrelation and avoid any contradictions or mis-coordination between the developed projections and accumulating knowledge.

This step develops over $1\frac{1}{2}$ to 2 weeks. By the end of this step, the students' modelling skills are improved, and they have gained a sound understanding of how the lines they draw may appear in physical reality. This consequently improves their ability to develop masses and proportions in three-dimensions and to think of the project as a whole, rather than dealing with isolated two-dimensional projections.

Step V: Developing Architectural Projections

Having developed the model with regard to details of site plans and floor plans, students address elevations and cross-sections in the light of their developed models.



(A) (B) (C) (D)

Fig. 1. Sample of students' three-dimensional study-models: transformation by addition (a) and (b), subtraction (c) and rotation (d). Models by students: (a) and (b) Mo'az Hossam, (c) Tasnim Ayman and (d) Sama Khaled.

In *elevation* design, students deal with three aspects, namely: *masses, details* (i.e. fenestrations and environmental treatments) and *textures*.

Masses are mainly recognised by the model development. This usually requires updates to the layout and architectural plans and, naturally, to elevations and cross-sections.

When addressing the geometric and functional relationships between fenestrations and climatic treatments (e.g. shading devices), this usually requires some changes to opening positions and proportions, which may accordingly require updating plans and reorganising the furniture.

Giving thought to the textures adds a layer of reality to the students' work, and provokes them into thinking of the building materials that they may use, and how those may influence their designs. Ochsner [28] emphasised that physical materials have specific properties that dictate their use in the actual construction.

Students are also encouraged to think of *cross-sections* as design elements. They start to introduce changes to *internal and external heights*, and to use these changes towards improved *spatial relationships and environmental treatments*. Such changes are then reflected to the model, layout, plans and elevations.

It is evident from previous design experiences, that many projects were mainly challenged by a dominant context that designers had to recognise. In other incidents, the big ideas stemmed from employing a particular structural system, or developing an innovative treatment for levels to cater for specific modes of communication or circulation. Therefore, none of the above principles/steps is to be dealt with in isolation from the rest. They should all be integrated in a holistic way that recognises their physical and non-physical attributes, as applied to two- and three-dimensional elements simultaneously. It is inevitable though, that all projections are developed in constant coordination to realise the reciprocity between different design elements and ideas—no matter which projection comes first (this shows more clearly in the way 'phase two' steps are planned). This is why students are constantly encouraged to revisit their precedent design phases throughout the project development, in line with the feedback loops suggested in Archer's operational model [23].

Step VI: Final Presentation

This step sets the syntheses of developing all previous steps. Simple, yet concrete, architectural presentation techniques are promoted in accordance with student skills and abilities. The final product usually comes in A0 boards, representing site plans, floor plans, elevation(s), section(s) and three-dimensional study-models.

By the end of this project, students should have *gradually* and cumulatively learned about the required *design principles* (i.e. function and circulation; spatial qualities and structural stability; geometric relationships and proportions, orientation and climatic treatments; natural lighting and ventilation; site planning and contextual considerations; and elevation compositions and cross-sectional potentials) at an elementary level. This is accomplished having regard to the reciprocity between these design elements, as applied to floor plans, site plans, elevations, cross-sections and above all to three-dimensional models.

4.2 Phase Two

This phase is meant to introduce students to a more *systematic approach* to architectural design. It is primarily described in terms of Bruce Archer's 'operational model' for creative problem solving, and its subsequent developments [23, 35–37]. In this phase, students are *given a particular site* upon which they are assigned to design a simple building for a particular client/ product of their choice (e.g. a celebrity's house, a professional's residence, a specialised exhibition . . .). The magnitude of the project is intentionally limited to this scale to make sure that students can develop the process systematically working towards the attainment of desirable outcomes [6].

Unlike the previous phase, this comes in four steps:

- Step I: Research and analyses [programming + data collection + analyses]
- Step II: Three-dimensional modelling [syntheses + development]
- Step III: Developing architectural projections [syntheses + development]
- Step IV: Final presentation [communication]

The following discussion is an explanation of their content and the outcomes sought.

Step I: Research and Analyses [programming + data collection + analyses]

In the first step, students are required to undertake comprehensive studies in terms of environmental analyses (geographic, topographic, contextual and climatic), social analyses (users and activities) and relationship diagrams. This step involves site visits, data collection, precedents' investigation and documentation. It is carried out in groups of four at most, using different documentation techniques such as photography, photocopying, cut and paste, brief texts and posters. This work-group arrangement helps to conclude this step within the planned three classes.

In this step, students are expected to come out with:

- Elaborate architectural *programmes*, based on the type of users and functional requirements, whose significance can be seen in Tchumi's statement that there is no architecture without a programme [29].
- *Functional relationship and circulation constraints,* which will guide their forthcoming design steps.
- *Concept statement,* involving a layer of self-imposed constraints (symbolic analogy, historic analogy, canonic analogy, building typology . . .), which stems from the nature of product, client or context. According to Delage and Marda [38], a concept should not be an isolated changeless formation, but rather an active part of the intellectual process that caters for sound communication and appropriate understanding to the problem. This is done on individual basis.

Step II: Three-dimensional Modelling [syntheses + development]

Developing symbolic analogies in architectural design may commonly involve some vagueness, especially in the early phases of the design process. This requires *interpreting* sensed data into constructed *physical* representation [36].

Yet, students start, at this point, to materialise their abstract design concepts into simple physical three-dimensional study-models. Such models may represent their masses with cardboard, cork layers, soft Plasticine, or any easily-handled material of the students' choice. This step is developed over three classes, and remains in constant development throughout the rest of the project.

Step III: Developing Architectural Projections [syntheses + development]

Sketching is an important element in most design education methods. Sketches are essential represen-

Fig. 2. Sample of students' submitted projects. Projects by students: Amr Eraky (left), Omar Kordy (middle) and Diana Emad (right).

tations for thinking, problem solving and communication in the design disciplines. It helps the expression and the presentation of a designer's mental concepts [39].

Therefore, this step is about developing students' designs in terms of different two-dimensional projections *simultaneously*, bearing in mind all the functional, climatic, and structural regards they have learned about in 'Phase One'.

In order to receive the required emphases, this step is made over five weeks, through which no particular priority is given to *start with either* projection. Such a decision is primarily made on individual bases, in relation to each design concept and the nature of the project. The necessity is to constantly keep all projections in parallel development and coordination.

Step IV: Final Presentation [communication]

As in 'Phase One', this step concludes all previous steps. Simple architectural presentation is promoted, in accordance with student skills and abilities. On the top of Project One's submission format, students are required to introduce their analytical-study sketches, main concept statement and three-dimensional drawings.

In brief, Fig. 3 is a graphic representation of the above-studied model, showing the relationships between the constituents of its two phases.

5. Phases' relationship . . . Discussion

The graphic representation of Fig. 3 shows four main differences in the order of the steps between 'Phase One' and 'Phase Two' of the proposed model. First and foremost, 'Step I: research and analyses' appeared in 'Phase Two' for the first time, having been entirely absent from 'Phase One'. This step serves as an active springboard for the intellectual processes of sound problem definition, profound concept statement and hence an appropriate approach to design problem solving.

At the same time, 'Step I: Given Plan' of 'Phase One' has been totally eliminated from 'Phase Two', with its role fulfilled in the gradual learning about multiple interdependent design constraints.

Another difference was about getting 'Step IV: Three-dimensional modelling' of 'Phase One' to occupy the second place in 'Phase Two', immediately after the research and analyses step. This gains its significance from improving students' faculties in three-dimensional imagination, in terms of stimulating thinking, articulating and communicating ideas, testing hypotheses, and judging alternatives; hence enriching students' creative and imaginative faculties in architectural design, as well as promoting the transformation of abstract concepts into material objects.

The fourth and last difference is about the merger of Steps II, III and V of 'Phase One'. Together with the previous transformation (i.e. modelling just after research), this clearly promotes the sought-after *holistic understanding* of architectural design, thinking of a project as a whole integrated entity, rather than a bunch of *scattered disconnected projections*.

It is fully understood that the fragmentation of steps in 'Phase One' may momentarily look at odds with the sought-after holistic understanding of design, though it is crucial to look at it as an integral part of the proposed model. This temporary effect was only allowed in 'Phase One' for the sake of gradual learning in early design education, while it was entirely abandoned in the subsequent phase.

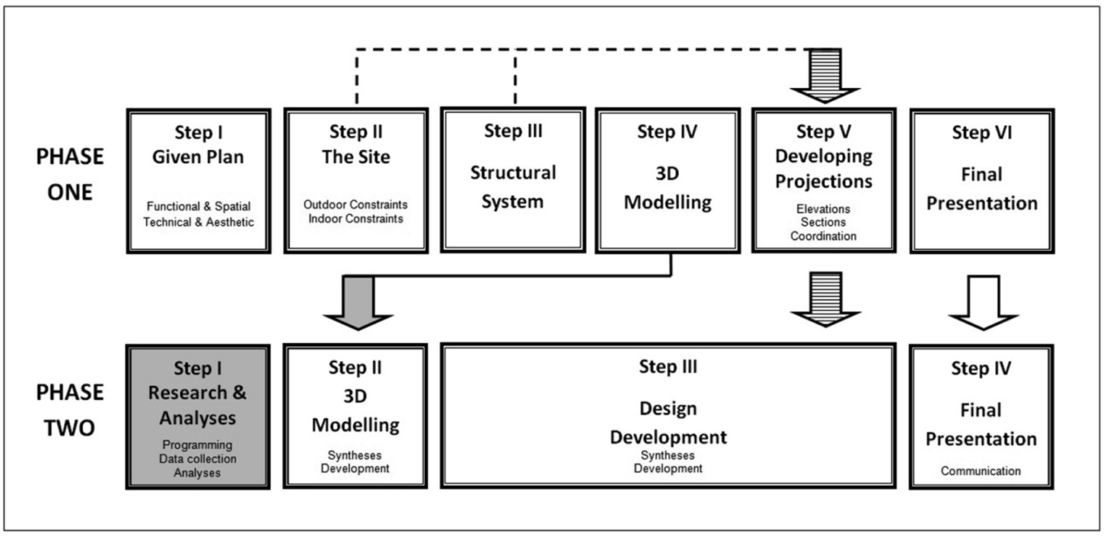


Fig. 3. The proposed model: transformation of steps between Phase One and Phase Two.

6. Course outcomes

By the end of both phases of the proposed model, the course outcomes can be described in terms of two main accomplishments, as well as a few detailed points.

The main accomplishment refers to students' eligibility for the following:

- developing architectural designs that reflect an understanding of the basic design principles, including: function and circulation; geometric relationships and sound proportions; desirable orientation and climatic treatments; natural lighting and ventilation; spatial qualities and structural stability; site planning and contextual considerations; facade compositions and cross-sectional potentials, all at an elementary level;
- mastering an appropriate understanding to the design process, with special emphases on its holistic nature and interdependent steps, as well as maintaining proper coordination between different projections throughout.

The other detailed outcomes include improving students' abilities in:

- developing simple architectural programmes, based on meticulous data collection, as well as sound environmental, social and relationship analyses of a given context;
- thinking critically and transforming abstract analogies into architectural applications;
- employing three-dimensional models to improve the imagination, stimulate thinking, articulate concepts, communicate ideas, test hypotheses and the assess different alternatives;
- criticism of own work, as well as the development on the basis of others' criticism;
- communicating design solutions through appropriate means with verbal and visual presentations.

7. Conclusion

In response to the limited design experiences previously possessed by 'design studio one' students, and the intense amount of information that they need to acquire, a process-based model for teaching 'Architectural Design I' was proposed in this study. The model aimed at regulating the amount of information delivered to students in reasonably attainable chunks that are not too fragmented to overlook their interdependence and interrelation, as well as undertaking an entire systematic design process to understand the sequence and relationships between its phases. In order to reach this objective, it employed two project-based phases. In 'Phase One' of this model, the gradual and cumulative revelation of design constraints helped students to realise the course requirements without being overwhelmed by the magnitude of their complexity and interdependence. 'Phase Two' introduced students to a more systematic process-based approach to architectural design.

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