International Journal of Technology Engineering Arts Mathematics Science
Special Issue 1, August 2023, pp. 282-288
ISSN: 2583-1224,

Stimulating the Building Construction Technology in Architecture Education

Prof. Swapna Dhavale[1], Prof. Shivani Gaikwad[2]

[1] Department of Architecture, G S Mandal's Marathwada Institute of Technology, Aurangabad, Maharashtra, India
[2] Department of Architecture, G S Mandal's Marathwada Institute of Technology, Aurangabad, Maharashtra, India

Corresponding Author: Prof. Swapna Dhavale ar.dhavalesa@gmail.com

Article Information

Article history:
Received Jun 10, 2023
Accepted Dec 10, 2023

ABSTRACT

With time, the teaching learning process as a whole has undergone evident and constructive change. Architectural education is no exception. Considered as a field of creativity and technology, architectural education has always been under an observational lens of innovations in terms of teaching learning methods and tools. In this era wherein the materials and construction technology advancements are very rapid and continuous, it becomes essential for the institutions imparting architectural education to evaluate, rescript and redefine architectural pedagogy regularly,so as to enable the student to meet the developing tasks in this field and be equipped with the necessary skill sets. This paper aims to put forward an experimented method of unraveling the thought process as Edification for fourth year "Special Structures" studio subject, which assisted to boost the ingenuity. A comprehensive approach was adopted through innovative means and methods as a key factor to attain the perception of higher level. To explore this approach, the paper will thoroughly discuss the process applied in the studio and analyze the process and development through selected students' work. The aim of the research paper is to document and analyze the findings for enhanced approaches to be adopted in future. It also aims in creating an experimental module to test the component with advanced tools, techniques, and software.

Key Words: *Architectural Education, innovative means and methods, Advance techniques.*

1. INTRODUCTION

With time, the teaching learning process as a whole has undergone evident and constructive change. Architectural education is no exception. Considered as a field of creativity and technology, architectural education has always been under an observational lens of innovations in terms of teaching learning methods and tools. Technological advancement has affected almost all aspects of human life including Education. It is the most critical aspect as the changes that this sector witnessed would have a long-lasting effect on the future generations of any and every nation. India being a developing nation with a population of 1.3 billion is not an exception. Our Country has immense network of institutions imparting higher and technical education. It is considered to be of great importance in the global education industry.

As per statistics there are around 580 academic institutions imparting Graduational Architectural Education in India, where approximately 20,000 students are enrolled every year.

2.BUILDING CONSTRUCTION TECHNOLOGY EDUCATION

The UNESCO/UIA Charter for Architectural education 2017, asserts "An ability to create architectural designs that satisfy both aesthetic and technical requirements' as a major objective of Architectural education It further emphasizes that architectural education should be aimed at acquiring an understanding of technicalities of structure, material, and construction. Understanding

of the procedures of specialized design and the amalgamation of structure, construction expertise and service systems into a functionally effective whole. This clearly put forward, that study of Construction Technology shall be thought as an vital and an integral subject of the design process, and this amalgamation should be considered while designing and processing the academic assignments.

Architectural curriculum in India is governed by the Council of Architecture India. Minimum standards of Architectural education as prescribed by CoA, focuses on three core subjects – Architectural Design, Technology-based Subjects – Construction technology & materials, structural systems, and the third , services allied field subjects like Interior, landscape, climatology. Each group of subjects focusing on expanding students' design knowledge and skills, the scientific features of architecture, develop expressive skills. The subject Construction Technology & Materials has a convincing relationship with aesthetics, function as well as structural stability. *As Vitruvius stated in his Vitruvian Triad , Firmitas*

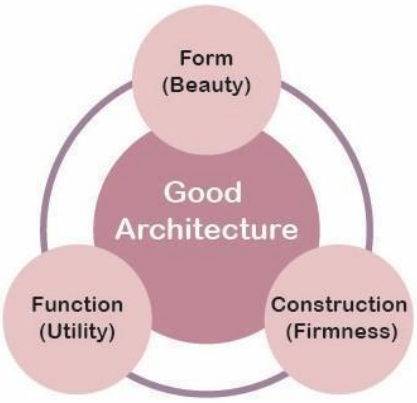

Figure 1 Good Architecture (*Source: Author)*

(Structural Stability), Utilities (Practical Function) and Venustas (Aesthetics) are equal attributes of design. The said aspects of architecture can be interpreted in a simplified way as form, function and construction (*Refer i)*

In today's era architectural design and construction are already experiencing a paradigm shift in its conventional approaches to the digital - more specifically computational methods. The architectural students of the era are curious and fascinated by this novel field. As an educator it's a pedagogic challenge to enhance the knowledge and skill set of the students so as to respond to the enduring curiosity and navigate the mindsets and perspectives for an enriched learning outcome.

2.1 USE OF TECHNOLOGY IN BUILDING CONSTRUCTION TECHNOLOGY EDUCATION.

Technological advancement has a large influence on architectural education. Due to this paradigm shift the possibility and evolution of architectural design could be emphasized by an advanced approach in computational environments. Students can boost their intellectual level by manipulating these advanced and intelligent technologies. In this era wherein the materials and construction technology advancements are very rapid and continuous, it becomes essential for the institutions imparting architectural education to evaluate, rescript and redefine architectural pedagogy regularly,so as to enable the student to meet the developing tasks in this field and be equipped with the necessary skill sets. The focus has shifted to upskilling and generating essential aptitudes among students; to stimulate and encourage thoughtfulness, reflecting ability, commitment, and self-strength of mind for evolving state of the architectural solutions.

For introducing the advanced tools for design solving on structural level to final year architecture students, an experimental approach was adopted to understand and implement this concept through the subject of special structures.

3.UNRAVELING THE THOUGHT PROCESS: CONDUCT OF "SPECIAL STRUCTURES - STUDIO"

Architectural education has conventionally been composed of a sequence of projects and exercises that use replacements in the form of drawings and models that are intangible in nature, to learn and to test conventions about physical objects in the real world.

This allows a virtually unlimited freedom to explore hypothetically; and the Hypotheses are then tested through discussion and critique (e.g., the design jury). This traditional method of teaching generally relies on Knowledge, Facts and evidence.

The initial step in incorporating the new approach to gain the anticipated knowledge and understanding is identifying the perceptible components that accept computing in this subject so as to establish an appreciative integration. The prescribed Syllabus offers scope in the following topics:

1. Geometry of forms.
2. Derivation of form and construction.
3. Form finding methods.
4. Development of simple forms.

The research shows that using the digital design method assists in elevating the form exploring ability of the student with increased creativity. This certainly is beneficial to have more diverse design alternatives.

The necessity for a convergence between studio design teaching and construction teaching dominated the majority of the interventions made. Thus, a hands-on approach with technologically driven innovative solutions was adopted. The first phase, which was the hands-on approach, required a lot of creative brainstorming so as to develop suitable solutions. While to gain innovative solutions technologically required modeling, analysis, and testing.

3.1 STUDIO BRIEF:

Current studio Pedagogy states that by the end of the course students should be well acquainted with Special structural forms resulting from special technologies.
The Studio based subject is thought aligned with the objective and the detailed prescribed syllabus, which states 3 basic modules as,
1. Geometry of forms. Shell structures and their structural behavior. Space frames and Geodesic domes – derivation of form and construction
2. Folded plate structures. Design of simple V type of folded plates.
3. Membrane structures. Form finding methods. Planar grid and curved grid structures. Advancement of simple forms and scale models.
Being the last semester where the subject is an extension of Building Construction Technology as a core subject. The aim of the subject being, to introduce and teach "traditional and conventional knowledge systems that enable construction of a complete building: various structural systems and methods of construction using natural and manmade materials". (CoA MSAE 2020)
The course is in combination of lectures and studio exercises resulting in the form of drawings and models. Introduction to be made along with advantages and precautions. Study long span structures in steel and concrete. The Knowledge gained is evaluated as continuous assessment and Viva Examination at the end of the semester.
The pedagogy focuses on better understanding of structural systems and the form selection which shall support the student to make possible what has been perceived as a concept or design, that is to make architecture the way it is meant to be.
Dealing with long span structures, it becomes even more apparent to be well-equipped with the basic understanding and study of,
1. Classification of Systems
2. Evolution and Examples
3. Advantages and Disadvantages of various Systems
4. Structural behavior of each.
5. Accuracies and precautions
6. Material of construction to be adopted.

3.2 THE PROCESS APPLIED

The revised Pedagogy focused on understanding the Structure, Form and Architecture and the relationship between them to enable the students to have enhanced ability for selection of structural systems and the form selection which will essentially support making the architecture that they abstracted.

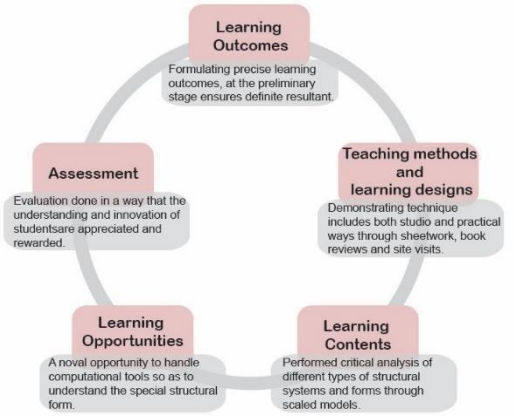

Figure 2 Process Applied (*Source: Author)*

Hence the Teaching and Learning process focuses on outlining the exercises and assignments with the learning outcomes as mentioned as per the studio brief. After completion of the course the student shall be able to make a distinction and decide to adopt a particular structural system along with the comprehensive knowledge of essential construction technology and material for long span structures.
To meet the derived learning outcomes the three modules as prescribed in the syllabus are further detailed along with the exercises.
The exercises are broadly classified as
1.Drawing Sheets
2.Scaled Models
3.Software Generated Models
4. Site Visits and reports.
The accumulation of knowledge is to be presented in the form of a portfolio.
To improve the current pedagogy, the New Approach of Digital architecture was adopted in the form of parametric computational methods.

3.3 ANALYZING THE PROCESS: THE BLOOM'S TAXONOMY

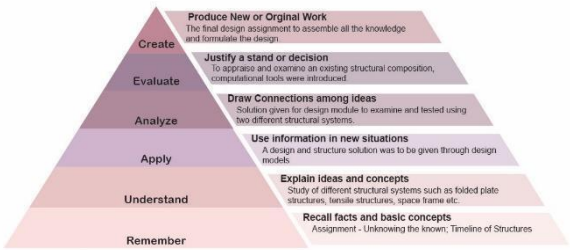

Figure 3 Analyzing the Process *(Source: Author)*

Remember: Recall facts and basic concepts. Assignment (Unknowing the known; Timeline of structures) The structures studied till date had a historic and design point of view. This was recalled and restudied, through the assignment considering the structural systems associated with it along with the era in which the structural systems were developed.

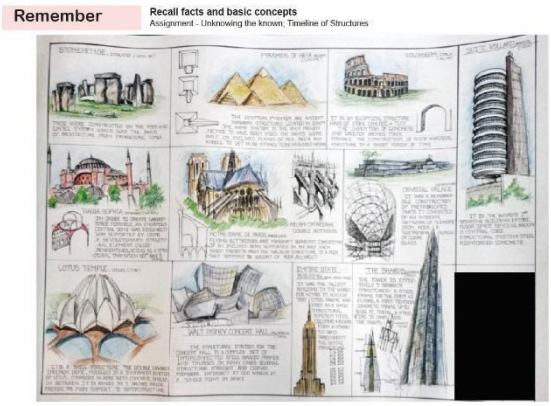

Figure 4 Recalling facts and basic concepts.
(Source: Students work, academic year 2021-22)

Understand: Explain ideas or concepts: (Study of different structural systems such as folded plate structures, tensile structures, space frames etc) The long span structural systems such as folded plate, tensile structures, space frames were introduced along with their classification and were discussed through sheetwork.

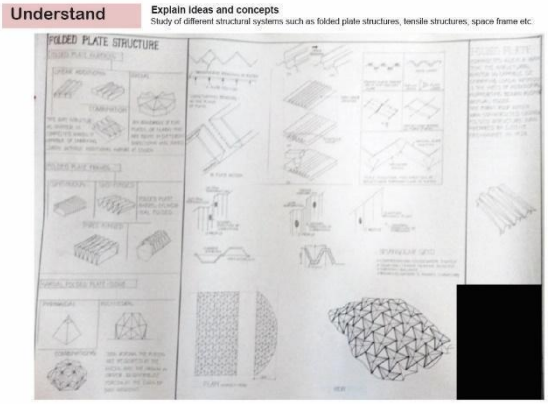

Figure 5.1: Explaining ideas and concepts.
(Source: Students work, academic year 2021-22)

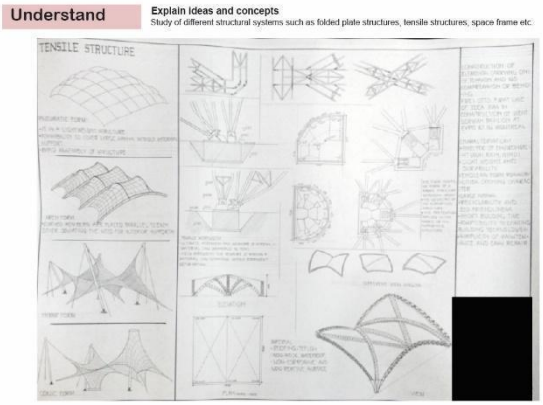

Figure 5.2: Explaining ideas and concepts.
(Source: Students work, academic year 2021-22)

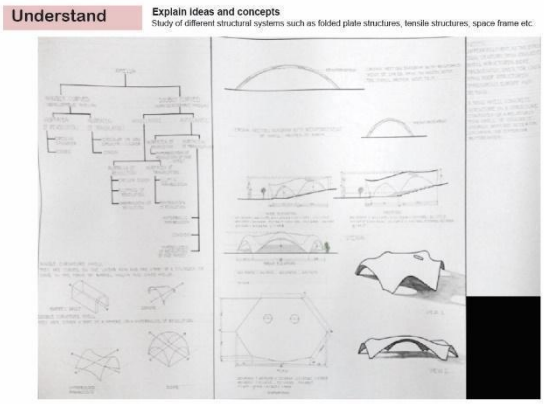

Figure 5.3 Explaining ideas and concepts.
(Source: Students work, academic year 2021-22)

Apply: Use information in new solutions: *(Understanding the structural system; A design solution was to be given through design models)*

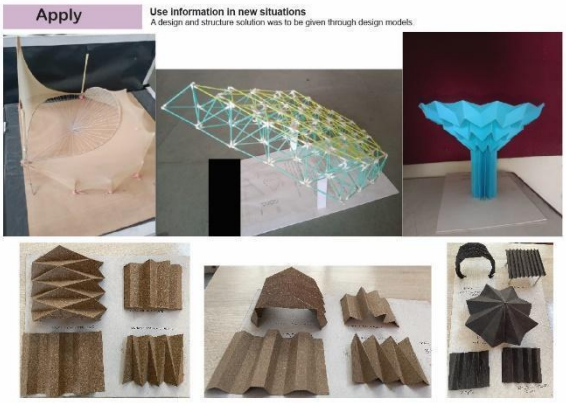

Figure 6: Using Information through scaled models.
(Source: Students work, academic year 2021-22)

Analyze: Draw connections among ideas: (The solution given for the design module was to examine and tested using two different structural systems) Implementation of the basic understanding of different structural systems was put to test through minor design problems where a space module was briefed, and the students were asked to examine two different structural systems that can be applied to the space module. The students demonstrated the distinguishing characters of the structural systems through sheetwork and scaled models.

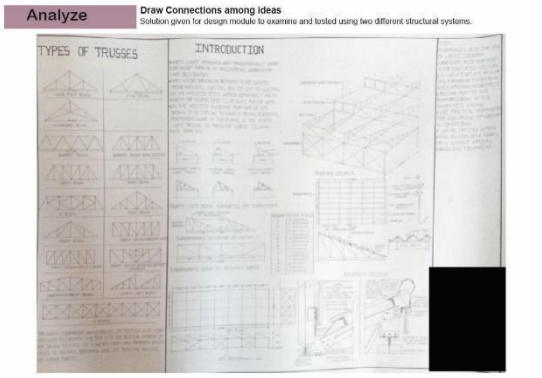

Figure 7.1: Solution given for design module using two different structural systems.

(Source: Students work, academic year 2021-22)

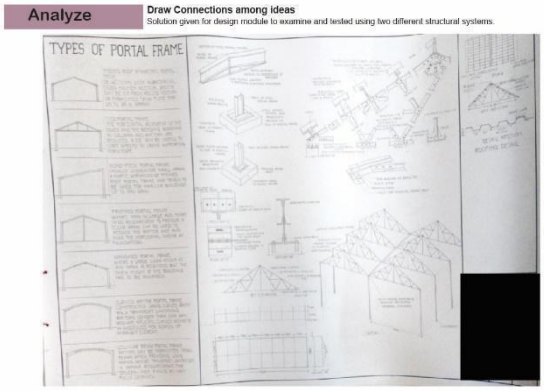

Figure 7.2: Solution given for design module using two different structural systems.

(Source: Students work, academic year 2021-22)

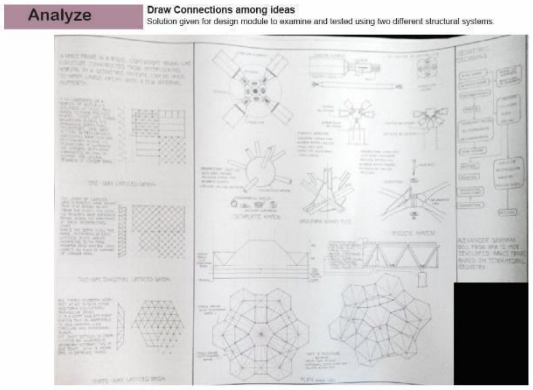

Figure7.3: Solution given for design module using two different structural systems.

(Source: Students work, academic year 2021-22)

Evaluate: Justify a stand or a decision: To appraise and examine an existing structural composition, computational tools were introduced. *(Rhinoceros and Grasshopper)* A case study assignment using computational tools was introduced to appraise and value an existing structural composition in terms of its concept inception to final formation.

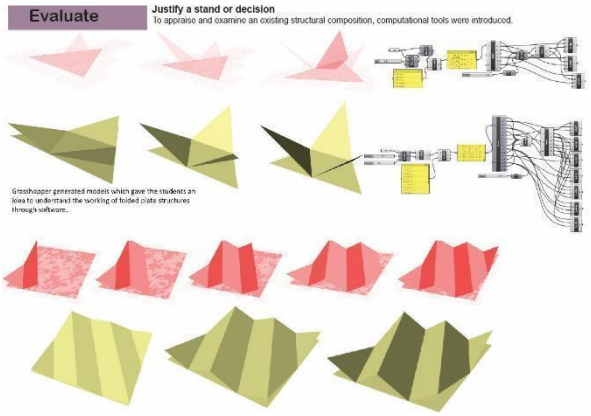

Figure 8: To appraise and examine an existing structural composition, computational tools were introduced.

(Source: Students work, academic year 2021-22)

Create: Produce new or original work: (The final design Assignment) Concluding stage was an integration assignment of construction technology and design process, where a "special structure" was to be designed. The brief introduced, challenged the students' knowledge gained and understanding of construction technology which they had to speculate in terms of design.

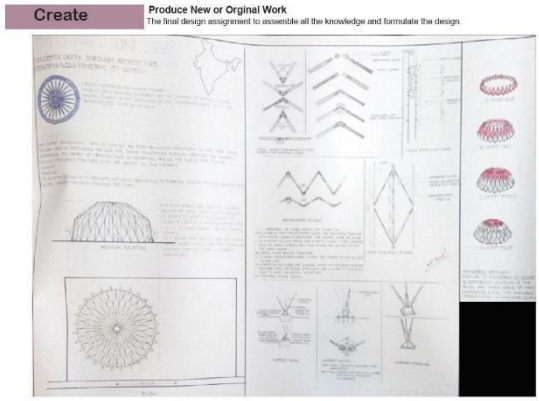

Figure 9: The final design assignment to assemble all the knowledge and formulate the design.

(Source: Students work, academic year 2021-22)

4. FINDING

This paper aims to focus on the teaching learning methodology adopted for developing a comprehensive thought process in a construction studio of fifth year architecture, through a very close scrutiny of the creative learning outcomes from the student's work so as to introspect and to put forth an experiment with its findings, that can act as an ongoing research to better formulate the needed approach suitable for architecture students in future. This paper gave the authors a whole vision for the different viewpoints and differentiates between the traditional teaching process and the integrated and directed architectural thought process.

The initial stage (stage I) emphasized making the students understand the relationship between the

structure, form, and architecture. It is important especially for the students who are pursuing architecture. This stage provided some insights on the better understanding of structural systems and its selection along with the form finalization which will support succeeding to the architecture design, the way it has been conceptualized. This phase acted as a narrative; through a stage wise development of the thinking process each student could contrive on their own projects with a determined notion.

Unknowing the known; Timeline of structures: The exercise offered the students an opportunity to recall and understand the geometry of forms through the timeline structural evolution. The study emphasized geometrical forms and their structural systems which helped them further in the design phase to generate the form grammar for the spaces to be designed.

Explain ideas or concepts: Study of different structural systems such as folded plate structures, tensile structures, space frames etc. The inputs from the faculty in form of lectures and site visits opened the avenues of a range of structural systems for the students to select from, for a given design project.

Draw connections among ideas: The exercise brought out the creative bloom in the students which was witnessed even in the design phase as the students didn't hesitate to come up with infantile but pragmatic ideas and transformed them in the minor design demonstrated by sheets and scaled models.

Justify a stand or a decision: A case study assignment using computational tools: The exercise assured that the students appraise and value an existing structural composition in terms of its concept inception to final formation. This had a long-lasting impact on the minds of the designer/students, which got reflected in the Design Phase in form of the concepts and final design outputs.

The whole journey had an eternal influence on the students as they started to enjoy the process from unknowing the known, then progressing to a better understanding of form-structure relationship with more passion to succeed in a better architectural design phase rather than treating it as problem solving sessions.

5. DISCUSSION

Architecture is the study of buildings, from designing to implementation to handover. A building is not just about planning and designing spaces for a specific utility, knowing how to construct it using the most appropriate Material and Construction Technology is equally important. The methodology of the teaching process is an important and prime factor that governs not only the outcome but also affects the creative ability in the development of innovations. Teaching a construction studio is not mere transfer of technical knowledge but shall provide a direction to the creative journey of the mind set aspired for an architectural student. To meet this objective, it is very important that framing of assignments is target oriented, and the target is known and clear, for which a conscious learning strategy is to be formed and the process is stage-managed or sequenced accordingly.

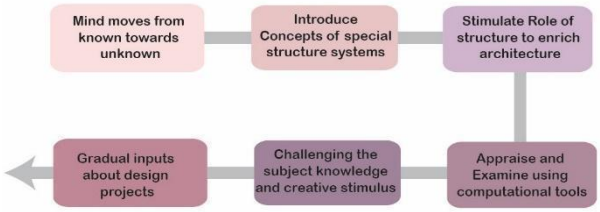

Figure 10 Learning Strategies – Sequence in process
(Source: Author)

6. CONCLUSION

This paper aimed to put forward an experimented method of imparting a well formulated academic process which helped students to bring out their ingenuity. The objective was enhancing student's experience in the implementation of designing concepts with a clear understanding of Special structural forms resulting from special technologies. It was a good opportunity for the tutor to develop the way of introducing the knowledge and skills. A conscious perpetual integration of Knowledge, Skill and Creativity in the architectural construction education would help retain the core of design and construction in the phase of globalization.

ACKNOWLEDGEMENT

We would like to thank our colleagues from the institution who provided support and expertise. Their insights greatly assisted the process. Most importantly we are thankful to our distinct class of students who inspire us to reflect on these aspects. We thank "anonymous" reviewers for their insights. Errors if any are our own and should not impair the reputation of any in person.

REFERENCES

1. The-teaching-of-construction-in-architectural education.https://www.eaae.be/wp-content/uploads/2017/04/12_the-teaching-of-construction-in-architectural-education.pdf

2. Pedagogic approach in the age of parametric architecture: Experimental Method for Teaching Architectural Design Studio to 3rd Year Level Students.https://www.researchgate.net/publication/282757784_Pedagogic_approach_in_the_age_of_parametric_architecture_Experimental_Method_for_Teaching_Architectural_Design_Studio_to_3rd_Year_Level_Students

3. Saul McLeod,updated (2017)Kolb's Learning Styles and Experiential Learning Cycle. Available: https://www.simplypsychology.org/learning-kolb.html

4. Chris Deidericks, 2006, Developing creativity and meaningful education in creative process at tertiary level, The journal of independent teaching and learning, volume 1. :https://issuu.com/theindependentjournalofteachingandl/docs/thejournalvol12006