

Implementation of Project-Based Learning Using Design Thinking Process in Post-Disaster Adaptive Building Design

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ABSTRACT

The demand for design skills in the world of work is increasingly high for the ability to process designs, both through an understanding of architectural science and the ability to experience design technology knowledge which is increasingly moving dynamically. While the process of learning architecture is learning that is dominated by architectural design in design studios, which aims to strengthen the ability to innovate in practice. This research develops a comprehensive analysis procedure regarding the problems that exist in the learning process of designing in architectural courses on disaster response for architecture students. This research develops a design thinking process method using project-based learning methods in post-disaster adaptive building design projects. This paper outlines the important components in the design process and shows the final results of the design in the learning process for the above courses. And the results show that this method can explore problems in the field comprehensively and can increase student involvement in exploring the latest design technology capabilities and developing adaptive design communications with users. So it is hoped that this procedure can be used as a reference in the learning process of the course so that the competency objectives of architectural education are met.

INTRODUCTION

In architectural education for undergraduates, the studio is the main point or core. The studio is an imitation of the real environment of the architect studio. In the design profession, the term "*studio*" is used rather loosely to describe the physical space, as the actual place where learning and teaching activities take place, as well as the engagement space of in a pedagogical strategy. To further complicate matters, the term is also used by professions to describe places of work activity [8]. The Architectural design studio is the only place for activities to design an architectural design project. Therefore, the statements presented above underscore the importance of interrogating architectural design studios. The studio became the principal medium of architectural design education, and conversations (especially associated with criticism) between students and tutors became the means of this education. Here students are expected to learn by doing. However, conversation, which may be in one of the following forms as one-on-one, table or jury criticism, is overwhelming fragile [9].

What are the students designing in the studio? There is project-based learning (PBL) as a studio approach. Project-based learning is a practically oriented pedagogical model, in which students develop their expertise in the content area being studied by working with cases and problems that represent real-life situations and actually occur in society [2]. There are transformational changes happening to the way we live and work. The economy is becoming increasingly complex and globalized, and new technologies are bringing unexpected

disruptions to the world of work. The types of skills that young people need to thrive in the future workforce are also changing [22].

Real problem-based learning in an architectural design studio is an important approach in architectural design pedagogy. Because of this approach, we can have three important basic skills, namely like complex problem solving, critical thinking and creativity [18]. Real problem-based learning can be linked to lecturer research and community service. There is a progressive loop system in the Tridharma of Higher Education [3].

The process of understanding to the design context in architectural practice is limited to exploring the physical qualities of architectural objects within certain predetermined limits [2,13,19]. The process of understanding context, often described as site surveying, relies on rigid site abstractions, which then reinforce other architectural propositions as object-based rather than relational constructs [2]. There are new architectures that are starting to offer more complete, creative and interesting forms of understanding contexts [2,16]. This paper tries to show that a design process with an understanding of a particular environment-based context will be able to significantly expand this discourse for society [14]. Besides its benefits for the wider community and can be realized, the product will provide true happiness and comfort for its users [24].

Because the design process is to cultivate the ability to think critically and creatively in order to develop ideas and design ideas. Architectural design learning is carried out through design projects in studio classes that integrate various knowledge and skills, such as: factual knowledge, environmental context, engineering context, design methods and communication techniques [3,4,26]. The learning process of architectural design studios based on learning real problems in the field is an important approach in architectural learning which is expected to have a real impact on the wider community which is based on important aspects, namely solving complex and real problems, critical thinking on real conditions and developing creativity [1]. It is hoped that this will be realized in architecture education as part of the *tri-dharma* of higher education.

The case of this research was carried out on the implementation of designing in the Disaster Response Architecture course in the Architecture Study Program at UPN Veterans East Java as part of an elective course in 5th semesters. Where each student gains the ability to design specifically in disaster response conditions that occur in several regions of Indonesia; by developing critical, creative and communicative thinking skills [26,19], in interactions between students, supervisors and lecturers during the design process. The design context also emphasizes the relationship with the surrounding environment and maintaining a sustainable

environment which is the goal in designing by following the basic principles of space and needs, technology and prevention or adaptation of environmental conditions that are responsive to environmental damage or other disaster conditions in a systematic and logical manner. This approach is a demand for global education and current learning methods in architecture education. In local educational practice, priority is given to conceptual design methods, creative sketches, imitation of the workings of modern architects, quick sketches and other methods of stimulating creative activity [6]. Various pedagogical methods to train creativity based on intuition, intensification of imagination, associative thinking and heuristic skills are tried by local educators with the aim of increasing students' motivation and interest in education. However, in recent years, a decrease in students' motivation to learn and a general lack of creativity has become very noticeable. A large number of students at the initial stages of working on a project face the same problem, that's a lack of ideas. Sitting over a blank sheet of paper and looking for inspiration, students often need support to facilitate their idea generation and design process. Indeed, students experience confusion during the design process, especially at the stage of generating ideas [5].

The most important recent shift in education, especially in design learning, is the increasing market demand for design standards that are competitive and implementable. The need for learning to adapt to an ever-changing world is the main reason for Project-Based Learning *which* is implemented in today's modern design learning processes. This learning is simply defined as an instructional approach that contextualizes learning by presenting students with the problems to solve to making design solutions [5], and asserts that project-based learning strategies are developed in a constructive approach system with environmental facts. Characteristically, the principles of Project-based Learning are accurately derived from cognitive and social constructivism both embodying the main strands of constructivist theory. Project-based learning strategies stem from constructivism, an approach that derives from understanding the precedents in earlier works and the natural or non-natural environment that formed them [10].

Based on the thoughts outlined above, appropriate steps can be taken in the study to develop an in-depth design and establish an appropriate work style [12] and emphasizes the learning process for developing abilities [6]. Due to the demands of technological advances and demands for creative ideas or ideas that can be developed with three-dimensional modeling using professional architectural software, even now the development of parametric designs has become a trend [26]. Currently, the demands of creativity and professional skills of an architect the future are in accordance with the purpose of the research.

II. METHODS

This paper was prepared based on the *exploratory research* method by observing the studio learning process carried out in the Architecture Study Program at UPN Veterans East Java and the results obtained in the studio learning process in the Disaster Response Architecture Course which was carried out in Semester 5. In this study program, they have a mission to provide superior architectural learning and lead to the development of architectural knowledge that is adaptive to the needs of society and the surrounding environment . This research is used to understand and investigate problems that can be collected in the field that cannot be clearly defined so that a description of conditions and problems in the field can be better understood or new problems that may arise during the design process so that the design can be carried out effectively and optimal [15].

Any design challenge can be solved by identifying the systemic complexities in the problems. To understand the complexity of the design, the research process was carried out using the *Design Thinking method* [23,20,7]. A method that develops tracing design problems during the design process, this is done so that the problems that arise can be identified and their characteristics understood and their influence on design decisions [15]. The aspects that were reviewed at the beginning of the research were user needs, design programming procedures and field characteristics of the project location. And at the end of the design a design assessment is carried out to analyze the perspective of project realization when the project is built on the ground [20,7].

The success of an architectural design process is influenced by the ability to apply architectural design knowledge sequentially presented in architectural design literature and software as the main support [23,11].

III. RESULT AND DISCUSSION

In the learning process in the Disaster Response Architecture course, it is carried out by developing *design thinking methods* with project-based learning in the case of designing disaster response architectural buildings at locations. Provision of shelter for post- affected residents is a very urgent need and it is very important to be held quickly to meet their next life needs.

Project Based Learning Post Disaster Home Design

In a project-based learning environment, students will gain knowledge and skills by investigating and responding to questions, problems, or challenges. Learning and teaching

addresses cross-curricular content through rigorous, authentic, hands-on and interactive learning experiences.

Project-based learning involves students in opportunities and opportunities to solve various and real problems in the field. It encourages innovation, critical and creative thinking strategies, and collaborative teamwork [21]. Students are driven by questions that are challenging and open and related to current projects and according to the real needs of society, the availability of technology and materials available in the field [17]. Even students will present directly to an audience of stakeholders or related partners in the community.

The project description that the plan will develop is a post-disaster temporary housing project located in the Lumajang disaster area, East Java, namely a simple house building that can be inhabited by residents affected by Merapi in Lumajang. It is hoped that this project will be a prototype residential building that can adapt according to basic space requirements and as a proper residential building in terms of the comfort and safety of its inhabitants. Post-disaster temporary housing is a type of house built temporarily to provide temporary shelter for disaster victims. This home is designed to meet basic human needs, such as protection from the elements, privacy and security.

Here students actively participate in the whole process, starting from gathering information and data in the field to explore the basic needs of the priority space and facilities needed, to the process of developing a basic concept of creative design, developing the use of appropriate construction and carrying out structural testing.

Design Procedure of The Design Thinking

Design thinking is thinking that involves using procedures to fully and comprehensively understand the design process [23]. This procedure is carried out so that design needs can be accommodated in the design process, the design can stand as a building that is safe and comfortable for its occupants, and have the opportunity to produce creative and innovative ideas that can be achieved according to real needs in the field and can be built quickly so that they meet the criteria for project success [26].



Figure 1. Design Thinking Procedure Model

(Source: Tymkiewicz, J. & Bielak - Zasadzka, M., 2016)

The design thinking model is a method of solving problems creatively and looking for innovative solutions [23] which includes:

- 1) Formulation of the problem to be solved; or identify and sort out design problems or demands expected by building users;
- 2) User requirements; needs that must be met by students in carrying out design activities, as well as user needs by looking at field conditions through field surveys together to understand field conditions and problems or obstacles that are expected to arise;
- 3) Exchange thoughts together, by holding *focus group discussions* in order to provide a broader and more comprehensive understanding;
- 4) Making prototypes, making several basic design alternatives to solving space problems, technology, material availability and their implementation in the field which can be used as design considerations;
- 5) implementation by optimizing the best design ideas or ideas into practice, and testing space comfort and building robustness considerations according to building requirements when implemented in the field.

Design creation process must be carried out in a comprehensive and interrelated manner, even the design testing cycle in the environment will be influenced by the importance of the environment and the design studio, and most encourage studio activities that require students to work as a team work [25].

1. Problem Identification and Formulation

1.1. Location Overview

Specific planning locations that have the complexity of the occurrence of disasters caused by the activities of Mount Semeru make it a problem and a threat to residents who are at the

disaster location . As a result of these conditions, especially during a disaster, which will result in damage and loss of shelter for local residents.

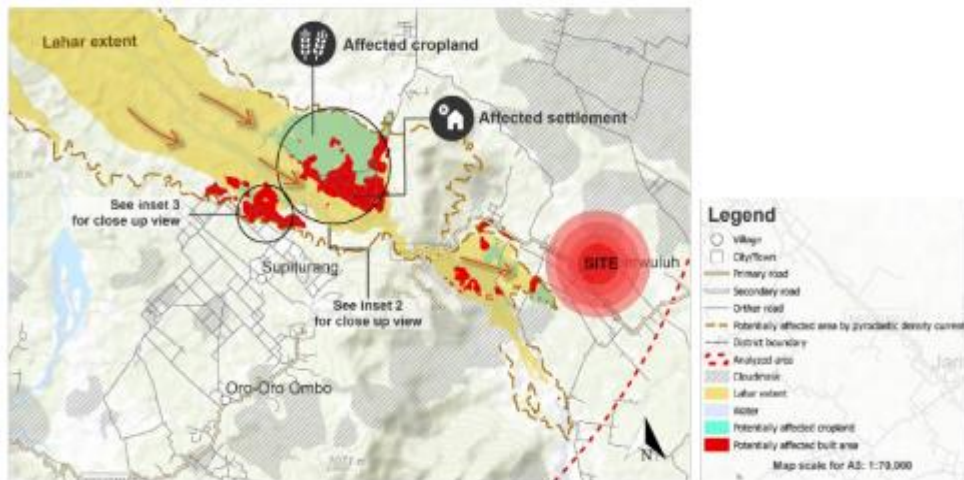


Figure 2. The area impacted by the Semeru Lumajang disaster

(Source: Unitar-Unosat, 2021)

The readiness to provide shelter for affected residents is very crucial. So that efforts to develop post-disaster adaptive buildings can be developed to address the availability of temporary shelters for disaster victims requiring further development of aspects of their reliability and resistance to loading conditions that are calculated to occur in the field.

1.2. Environmental Issues

The environmental conditions for the affected communities will be very concerning, they will be collected in temporary shelters which of course will have many limitations in terms of providing facilities for them, both in terms of comfort, health, limited space, availability of sanitation facilities, and even privacy issues.



Figure 3. Environmental conditions of temporary shelters

(Source: Excursion Study of UPN Architecture Documentation, 2020)

The absence of shelter for disaster-affected communities will cause very worrying problems, and will have a continuing impact on their subsequent lives. A house to live as a

temporary shelter for them is a very urgent and very important need to be provided quickly to meet their next life needs. The need for shelters that have domestic functions for the community is of course very much needed, especially for families that were previously separated by a disaster. These domestic functions include sleeping, bathing, and other important domestic activities.

2. User Requirements

The study learning process is strongly influenced by an adequate learning environment to develop students' potentials in the design process, and do not let this environment affect or even hinder the process of creativity and acceleration in the learning process.

2.1. Learning Environment

The learning environment in post-disaster architecture courses is structured according to the study method using a studio and each student has an independent study table that can be used for the design process, either manually or digitally using a computer.



Figure 4. Independent and group design studio

(Source: Documentation of UPN Design Architecture Studio, 2022)

2.2. Using of Technology

Drawing technology is used to visualize concepts and drawing results using several applications, such as AutoCad and SketchUp. This application is a program for creating image visualizations, both at the stage of developing sketches of shape ideas or 3-dimensional images quickly. Meanwhile, the finalization of basic drawings, such as floor plans, views and sections, can be done accurately using AutoCad. And these applications can be obtained at the Architectural Technology Laboratory.

3. Formation of Learning Groups

Study groups are formed according to the group of each supervisor who will work together to achieve predetermined learning targets. Formation of groups of approximately 10

students who will be supervised by one supervisor, starting from the beginning of the process to the implementation of the final design results. The guidance implementation process can be carried out together in a group or independently.



Figure 5. Independent discussion and group discussion

(Source: Documentation of UPN Design Architecture Studio, 2022)

With the formation of this working group it is very effective in monitoring the progress or development of learning outcomes at each stage, so it is hoped that the performance achievements of each student can be maintained consistently.

4. Design development (*design development*)

The expected demands of the design of this residence are that it can function as a home for the families of the disaster victims so that they can live in it properly and according to their needs, as well as fulfill their basic needs for comfort as a place to live. Besides that, in the process of providing the building, it must be able to provide the building quickly and do not need to follow standard development patterns that are known so far to take a long time to build, and of course it is safe to live in.

4.1. Space and Function Programming

In the design programming process carried out by students, it is carried out in stages including analysis of functions and space requirements, space organization and spatial programming . In order to understand space more deeply, a precedent study was carried out on other post-disaster building cases to understand the spatial requirements that often arise and the typology of forms that are more effective and efficient in terms of functions, materials and technology that have been used previously. The basic conception of space that students have achieved can be seen in the image below.

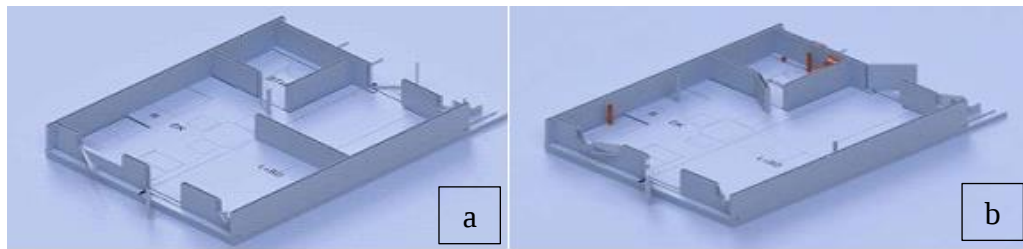


Figure 6. Basic conception of alternative (a, b) space that has been achieved
(Source: UPN Design Architecture Studio, 2022)

The spaces that have been formed on the basic concept are then adapted to the basic modules of space and structure that will be developed to facilitate the preparation of floor and wall areas based on the use of local building materials. Harmonization of form, structure and building materials according to the environment in which they are formed, the idea of this design is emphasized in the context of efficiency and adaptation to today's materials.

4.2. Design Implementation

The resulting design application uses materials that are light and easy in the construction realization process which is a fundamental requirement for post-disaster buildings. The use of materials that are light but strong enough to support the weight of the building so that it is effective when mobilizing implementation in the field quickly.

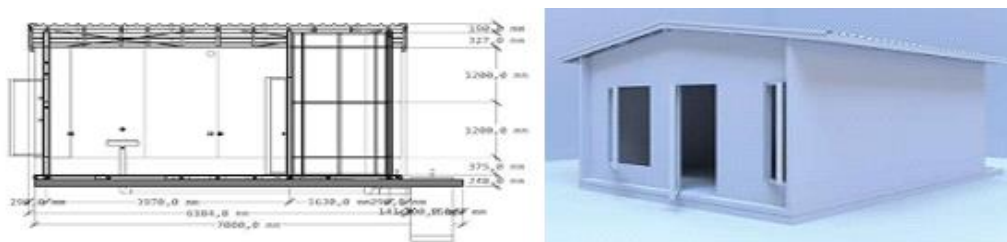


Figure 7. Building display application
(Source: UPN Design Architecture Studio, 2022)

Building components have also been arranged in a modular manner to facilitate fabrication so that it does not take long to provide them.

5. Design Testing

At this stage an independent evaluation was carried out by the students according to each working group with the emphasis being on testing on aspects of spatial comfort and safety aspects related to structural applications so that buildings can stand upright, sturdy and able to withstand vertical or horizontal loads, such as wind.

5.1. Space Comfort

The implementation of spatial comfort has been developed based on the basic concept of design which develops natural ventilation by providing openings that allow cross ventilation to occur . Meanwhile, to prevent the heat propagation from outside into the building through building materials is solved by providing heat absorbers to the wall materials and roof covering materials. So that the heat transfer from the outside does not affect the temperature in the room.



Figure 8. Window openings & building utilities

(Source: UPN Design Architecture Studio, 2022)

Implementation of the use of building utility systems to serve the use of clean water and sewage disposal.

5.2. Building Security

To maintain the robustness of the building caused by building loads and wind loads, a truss structure using mild steel material is used. The use of this building structure will be very efficient and effective in its implementation and resistance to the loads acting on the building.



Figure 9. The supporting structure of the building

(Source: UPN Design Architecture Studio, 2022)

Utilization of building modules that will facilitate the assembly of buildings so as to facilitate implementation and work in the field is faster and does not require a long time to implement.

CONCLUSION

From the results of research on the architectural design process in adaptive building design to disasters, several strategic conclusions are drawn in the design-based learning process that need attention, namely:

- 1) A conducive and proper work environment as a place to work that is able to encourage the creative process and build enthusiasm for working with entities together to achieve optimal design results;
- 2) The importance of working in groups to build an even understanding in thinking together, so that dynamic thinking occurs with various patterns of different perspectives in the creative process;
- 3) Technology application tools to visualize the creative process and realize the development of technical design prototypes and animations, perhaps even being used for the process of testing architectural buildings according to their individual needs.
- 4) The importance of field lectures together, so that students can see the reality of field conditions and problems that students can read with their respective perspectives in a variety of ways that can be used to develop design solutions independently.

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