PROCESS-BASED LEARNING: TOWARDS THEORETICAL AND LECTURE-BASED COURSEWORK IN STUDIO STYLE

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Abstract
This article presents a process-based learning approach to design education where theoretical coursework is taught in studio-style. Lecture-based coursework is sometimes regarded as lacking in challenge and broadening the gap between theory and practice. Furthermore, lecture-based curricula tend to be detached from the studio and deny students from applying their theoretically gained knowledge. Following the belief that student motivation is increased by establishing a higher level of autonomy in the learning process, I argue for a design education that links theory with applied design work within the studio setting. By synthesizing principles of Constructivist Learning and Problem-Based Learning, PBL students are given greater autonomy by being actively involved in their education. Accordingly, I argue for a studio setting that incorporates learning in studio style by presenting three design applications involving students in investigation and experimentation in order to self-experience the design process.

Introduction
A major curriculum change was adopted by myself and applied as an alternative to a theoretical course in architecture. The prior course was a lecture-based course that described form, circulation, components, function and design programs of buildings. The buildings were examined as finalized end-products and students perceived the buildings as typical and “ideal” design solutions. Being detached from the design studio this approach left little room for exploring design alternatives. This course followed a teaching ritual that disseminated theoretical reasoning to existing buildings and overlooked the benefits of examining the factors that impinge on the design processes. Since lecture-based courses are not linked with an applied educational setting, the knowledge gained was usually overlooked by the students.

Lecture-based education is a prevalent model in higher education. In architectural education, lecture-based curricula tend to be detached from the studio and deny students from applying their theoretically gained knowledge. Studies on past and present academic training have
indicated that practicing architects have diverged away from understanding the opinions and evaluations of the public. (Edwards, M., 1974; Groat, L., 1982; Devlin, K. 1990 and Gifford, R. et al., 2002). Meanwhile in undergraduate architecture education efforts to bridge this divide by integrating theoretical coursework with the design studio have hardly been documented.

With extra emphasis on conceptual design-thinking in studios and on theory in coursework, design education is veering away from overcoming practical concerns and solving problems. At the global scale and within the past 30 years, schools of architecture have witnessed extended attention to more abstract architectural theories dominating the schools' scientific method such as geometrical formalism and deconstructivism that have veered away from practice (Brown, G. & Gelernter, M., 1989). Architectural education is therefore diverging from the pragmatic issues of the discipline.

Furthermore, design studios are characterized by the ritual of producing designs involving “appropriately” performed procedures and actions (Maya, J. A., 1988). These vague procedures are formed by tutors' explicit or implicit view of design being creative and intuitive and therefore cannot be taught (Purcell, A.T., 1985). Studio instructors may also believe that the design studio is already the practicing ground for design training, an active mode of learning or “learning by doing” (Schön, D. A., 1987). While this may be true, the assumption is based on isolating drawings with no room for investigating the consequences of their designs or involving post occupancy evaluations of existing buildings. This suggests that the drawing board alone cannot involve students in investigating the outcomes of their designs.

Moreover the design studio barely incorporates theoretically gained knowledge from coursework. Students are often troubled as a result of courses being removed from practical contexts with an overall process lacking in clarity (Nelson, W. A., 2003). For the student, design is opaque in essence because the structure and logic of the design situation and process is seldom explained. On the other hand, the learning process inbuilt within the design studio acquires an abstract form of reality representation on the drawing board inheriting a limited view of the outcomes. The design studio is therefore mistaken for an applied approach, which in reality involves decisions to be made and designs to be created and remain on paper.

Both instructors and students struggle to identify the succinct success of the design at hand. Meanwhile, the more diverse and specialized theoretical coursework becomes more effort to integrate theory into the design studio is required. Furthermore, the disjointed arrangement between faculty being separately appointed to teach theoretical courses and others appointed within the design studio further impedes the integration of theory into the studio. While students are always required to incorporate their gained theoretical knowledge within conceptual design frameworks, methods integrating architectural disciplines and theory with design have hardly been delineated. We are inevitably in need for students to apply and critique lecture coursework using self-acquired knowledge. This can only take place when students are left to experience design using more applied teaching methods.
Experiencing Education

Without involving students' own experiences in their education it seems hard to assume that students would be able to think critically and understand how theory is constructed. Schön (1987) highlights how design inherits a dimension of experimentation that allows one to test her or his understanding of the design at hand and explore new phenomena. Schön’s writing suggests that experimentation takes place in learning by reflecting upon past experiences. Similarly, Dewey (1963) also presents a philosophy of education emphasizing experience, experiment, and purposeful learning involving the acquisition of cumulative knowledge. He further states that the role of the educator should not repel but engage students in enjoyable activities for promoting desirable experiences. Accordingly, education needs to be explorative, exciting, stimulating, and enrich the experience of education.

Student motivation is increased by establishing a higher level of autonomy in the learning process. On the other hand, instructors' involvement and bias is reduced when their role changes from being informants to becoming directors of education. Simultaneously, by developing students' research and analytical skills, students acquire the tools to gain self-learned experiences. Furthermore, by incorporating theoretical issues within design projects, students are able to critically examine and self-construct theory and further integrate theory within their design assignments. In this light I propose an approach involving two simultaneous objectives to design education to bridge the divide between theoretical coursework and practice:

1. Coursework in studio-style. This involves restructuring coursework for implementation in studio style. As an alternative to the design studio ritual solely taking place on the drawing board, theoretical issues are incorporated within the design studio by engaging students in experimental design applications. Concurrently, theoretical curricula are developed with the purpose of involving students in the design studio using models and simulations or realistic design situations. It is therefore necessary to create a more autonomous yet controlled educational environment for design training.

2. Process-based learning. This objective aims to develop a process-based learning context involving students in a guided exploration of the process of design. Consequently, the design applications mentioned above should allow students to actively investigate and assess each stage of the design process. This requires instructors to create design applications that allow for relevant learning issues (LI’s) to emerge. I therefore present the value of a process-based design education as a method for students to examine design using self-gained experiences.

To demonstrate, three design applications have been structured and presented below. The applications are part of a course in design methods and taught to junior students of architecture. The methods and results of three consecutive years of my observation of students in model making to experience the design process are presented below. First, I argue for a process-based design education that involves theoretical disciplines within design projects. For this purpose I suggest employing both principles of constructivist learning environments and Problem Based Learning PBL methods.
**Lessons from Problem-Based Learning PBL and Constructivist Learning**

Problem-Based Learning (PBL) was first introduced at the McMaster University Medical School in Canada in the late 1960’s as its major teaching approach in response to what were perceived as the limitations of traditional teaching methods. The underlying idea behind PBL starts from a learner wishing to solve a problem, question or puzzle. Its widespread application has been in the first two years of medical science curricula. It aims to counter for students’ memorizing of information and their lack of knowledge integration by motivating them to actively gather and analyze information.

PBL is not a mere problem-solving task that requires students to apply information by the teacher to solve a given problem. Conversely, PBL guides the design of the curriculum (Boud, D. & Feletti, G., 1997). Problem solving requires students to apply information provided by the teacher to solve a given problem. Meanwhile, with a PBL framework the problem comes first and students identify the information required to solve the problem. In medicine students in a PBL group generate learning issues LI’s that may later become a course topic (Koschman, T., Phillip, G. & Conlee, M., 2000).

Of the main characteristics of PBL, teachers act as facilitators to guide students to acquire self-directed learning skills, giving them the opportunity to learn and think on their own (Miflin, B. & Price, D., 2001). The role of the instructor remains insatiably responsible and might, however, yield some of their authority in the classroom setting (Allen, D. E., Duch, B. J. & Groh, S. E., 1996). Most PBL is well fitted to medical education, however much of it is incorporated in other disciplines such as social work, engineering, business, law, economics, management, mathematics, education, introductory university science, agriculture, as well as architecture (Boud, D. & Feletti, G., 1997). Subsequently, most PBL models have followed the example of the medical school, but have been differently adapted to the distinctive requirements of other disciplines.

The architecture department at the University of Newcastle, Australia is the first architecture school to adopt PBL principles (Drake, J., 2003). At Newcastle PBL is successively applied in stages of increasing complexity throughout a four-year course by specifically integrating technical and design areas (Maitland, B. (1995). However, Rambow & Bromme (1995) illustrate the substantial difference between medicine and architecture, particularly concerning specialist knowledge where architects’ knowledge is derived from diverse areas of science and differing aesthetic and stylistic viewpoints. Hence the main difference between architecture and other sciences remains in the range of theories offered by the diverse discipline areas of architecture.

Architectural education is challenged to incorporate architecture’s diverse and sometimes disjointed, discipline areas within a unified framework. Nonetheless, PBL indicates that coursework should allow students to identify design constraints in particular contexts thus addressing individual theoretical concerns. Consequently, the challenge in architectural education is to be able to create design assignments that can independently and collectively incorporate architecture disciplines areas.

Constructivist learning principles involve creating applicable environments suitable for learning.
Accordingly, constructivist learning environments incorporate curricula by involving students in self-assessing their design proposals. One of the many definitions of constructivist learning environments fitting to architectural design training is explained by Wilson as “...a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities” (Wilson, B. G. 1996. p.5.). Collectively involving students in exploring diverse solutions promotes knowledge construction and counteracts inexplicit instructor “guidance” that is seldom if ever explained.

Furthermore, constructivist models for learning elaborate on how one comes to understand. Savery & Duffy (1996) highlighted the primary propositions based on constructivist philosophical literature on learning and include the following conceptions: [1] “Understanding is in our interactions with the environment” where learning takes place as a result of our interactions with a given context for learning; [2] “Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned.” Here a problematic situation creates incentives for students to determine and acquire knowledge; [3] “Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings.” This assumes that learners are central to the education process by accounting for the relevance of what they learn as they construct their own understanding. Constructivist learning environments can therefore adopt different course objectives providing that students are collectively stimulated to participate in problem solving activities.

Constructivist principles create stimulating conditions for learning environments to promote self learning. Similarly, PBL engages students in self learning, however it bases learning on students’ experiences of more realistic educational concerns. Both promote a higher level of student engagement within a given context and share in creating an educational context for experimentation and learning. In brief, constructivist philosophy and PBL facilitate a self-directed learning process by engaging them in collaborative decision making to given problems. (Due to space limitations, an extensive discussion on the philosophy and range of application of these approaches and I recommend the reader to the work of Brent G. Wilson (1996) and Dorothy H. Evenson and Cindy E. Hmelo, 2000).

The above educational methods have appeared due to the institutionalized isolation between theoretical lecture-based courses and application. Their goals are to primarily integrate between diverse discipline areas and bring theory closer to practice. They are responses to the diverse specializations within different discipline areas and aim to merge them within applied learning environments. In architectural education the same divide is witnessed between theoretical curricula and the design studio. Architecture curricula should allow students to bring about the LI’s within each discipline area. This implies that we need to reconsider the manner in which we instruct students of architecture to bring theoretical issues closer to design studio training.

Coursework in Studio-Style

The conditions for creating constructivist learning environments require the creation of applied
Learning environments. It is usually the case for the architect that the studio presents the environment for experimentation, however it cannot become the sole basis for an “applied” education. In design training it may seem difficult to find alternative educational environments to examine design processes progressing only on the drawing board.

Further obstacles are created within the academic environment granting greater autonomy and freedom for faculty members to develop their own individual discipline areas. This in turn furthers the divide between studio and theoretical teaching where the instructors’ own theoretical experiences and bias is inevitably passed on to students. This is reinforced by the instructor’s choice of problems relating to her/his own specializations and their own view of the daily concerns within architecture. How can we then leave it up to students to choose the relevant theoretical issues within their design proposals?

The answer remains in the way we educate students of architecture. Nelson (2003) suggests that for solving problems, classrooms should be used as studios. This requires that design activities depart from the drawing board and leave space for students for investigation and evaluation. Simultaneously, curricula must involve problems that give students the chance to learn how to incorporate theory for solving problems. In conflict to the master-apprentice model, constructivist principles create a solid base to guide more applied educational methods. Theoretical coursework can be structured to integrate courses with studio projects covering various topics within architecture.

If design programs are constructed to include theoretical concerns, students would be stimulated to incorporate theoretically gained knowledge into their design assignments. Anderson and Puckett indicate that in-class problem-solving activities engages students in a variety of solutions to a single problem (Anderson, R. S. & Puckett, J. B. 2003). This suggests that by integrating theoretical conceptions within design projects, diverse design solutions are produced. Design projects inheriting problem-solving tasks also afford the possibility for students to collaborate and learn to negotiate and make collective decisions.

This can be achieved by allowing students to experiment within the studio using models that materialize the various stages of design, allowing them to evaluate unexpected outcomes and judgmental errors in design procedures. In turn, such a process limits the involvement of instructors in the overall process and the instructor is left to instigate discussions around the outcomes of the process. Moreover, design training should address design processes and aim to produce new LI’s within the studio. In this case the classroom, traditionally used for disseminating ideas from the literature, becomes a platform to develop and discuss outcomes of the design at hand in studio fashion. When classrooms are ritually shaped as design studios only then can students be directed to function as designers.

**Process-based Learning**

Imagery is often perceived as a central concern in architectural design, drawing the overwhelming attention of architecture critics as well as students. In the footsteps of schools of art, architectural media predominantly exposes new architectural form based on the contemporary aesthetic.
Within the design studio, the processes that shape buildings are overlooked at the expense of the final form, which has hijacked the focus of architecture. Furthermore, the proliferation of architectural styles limit the production of diverse architectural design solutions.

Akin (1986) suggests that architectural presentation simplifies design to create an abstraction of the whole design process. He further indicates that “...most contemporary stylistic ‘theories’ aim to develop systems of constraints which can be imposed on the design problem and reduce the uncomfortably large number of degrees of freedom which have been created by technological advances and breakthroughs.” (Akin, 1986, p.94.). Style reduces all the demanding problems and the many possible design solutions to a single choice. This dismissal threatens architectural diversification, leading students towards a more formal type of design driven by inspiring “new” architectural forms. Style therefore undervalues the design processes that respond to diverse discipline areas of architecture. Architectural education is therefore must subject students to the intrinsic processes of design, shaping the final form of the architectural product.

Scholars have grappled to explicitly identify the design process, and Schön (1987) explains that the design process responds to the unexpected outcomes taking place by “reflecting on action” by thinking back on what we have done (p. 77). Maya (1988) states that the design process is systematically taught with the first step of the process being data collection; consecutively design tutors instruct their students to follow what is a basis of “good” design.

Their observations and writings are produced from a design ritual involving a two-way process between instructor and student in the studio. Such a ritualistic context restricts students’ freedoms to explore alternative possibilities, as they are limited by the design program and dictated by instructor guidance. On the other hand, design education emphasizing the design process presents a response to everyday experiences and the socio-economic and political fluctuations in theoretical reasoning.

The Royal Institute for British Architects RIBA Handbook suggests that the design process is separated into stages: assimilation; general study; development; and communication, and are not necessarily in sequential order. Lawson’s (1999) book How Designers Think describes these stages as a sequence of distinctly identifiable activities, which occur, in some predictable and identifiable logical order. Similarly, Akin (1986) explains that the product does not result from a random process and is based on conscious cognitive thought. However, Lawson explains that because the design process takes place in our minds, it is not a clearly explicit process. Nevertheless, the definitions highlighted here indicate a process that takes place during the design activity and requires an informed response to the relevant information gathered. By capturing these different stages, students need to be aware of the individual design phases and address them with a holistic design reaction.

In light of Lawson’s explanation of the design process, I carry on this conception as an antithesis to studio instruction emphasizing on the final form/design product. Following this conception, design is therefore guided by a set of “design constraints” (Lawson, B., 1999, p.174). Design
constraints have been categorized by Lawson (1999) as: radical; formal; internal; external; and practical constraints (e.g. materials and the construction system are practical constraints). This avoids extra attention to more subjective aesthetic values, which are significant within the design process and shape the finalized design product. It suggests that the design product results from a complex relationship between various design constraints that are sometimes also used to guide the design process (Lawson, 1999). Design training is inevitably exposed to diverse problematic constraints and require problems to be solved to develop students’ own analytical skills. Consequently, students should be trained to identify design constraints and develop their own design principles in response to simplified problems.

The criteria for simplified problems are clearly outlined by Weiss (2003) as stimulating activity and engagement to promote higher order thinking among students. Weiss (2003) suggests that such problems should be: appropriate for students; ill structured; collaborative; authentic; and promote lifelong and self-directed learning. Design training therefore requires a degree of puzzlement to generate an entertaining learning environment that involves students in competitive interactions. Weiss’s view for simplified, ill-structured models is of value predominantly for junior students of architecture at the early stages of design training.

I shall present below three applications for junior design students. They are presented in a studio-style format based on a process-based learning approach allowing students to examine individual design stages by incorporating ill-structured problems. However, it is my view that more developed problems reflecting demanding concerns of professional practice should be involved at the senior stages of design education. Nevertheless, all stages of education require process-based design training as a medium for design education. Following both constructivist principles and PBL methods, I suggest the following guidelines as a structure for process-based design applications. The applications aim to engage students in exploring the design process and make clear the design decisions made throughout the process. I therefore propose the following objectives for a process-based design education for implementation in studio style:

1. Design applications should be unique and include puzzlement to unfamiliar design problems. Design applications need to be challenging and stimulate investigation. This requires that applications avoid predictability by incorporating unfamiliar design tasks.

2. Limit the number of design constraints and encourage the production of design alternatives. Design is subject to numerous design constraints that are often hard to determine. As mentioned above, many design constraints encourage designers to give attention to certain issues at the expense of others. This results in the filtering of valuable data, usually leading to subjective judgment throughout the decision-making process. On the other hand, junior students should be trained to respond to a limited number of clearly identifiable design constraints and have the opportunity to develop different design alternatives to the same challenge.

3. Students should work in collaborative groups and participate in collective decision making.
Students are encouraged to work in groups, investigating and sharing information to take decisions collectively. This encourages students to participate in debate and advocate their proposals as in professional practice.

4. Students should take control over their design applications and raise learning issues LI’s for generating in-class discussions. By liberating students from authoritative instruction, learners conduct research and produce learning issues derived from the task at hand. In turn, instructors should not dictate to students throughout the design process but must only assume the role of the coach. In this case, students take full responsibility over their design solutions and are responsible for conducting their own research to bring about the demanding learning concerns from within their assignments.

5. Utilize the LI’s raised as an outcome of previous design applications to develop future coursework. The learning issues being raised after evaluation should be used by instructors for developing future course objectives and refine course requirements. Here course objectives are developed with new information addressing up-to-date concerns.

For the purpose of creating a studio style setting, Figure 1 presents a general model indicating three main stages shaping the relationship between instructor, student, and the studio. The diagram presents a sequence of related procedures that give structure to a studio style learning environment. The instructors’ role is in this case detached from the studio setting; however, instructors are involved in identifying the general course requirements and make use of learning issues raised from students’ involvement with earlier applications. Accordingly, the input from the course objectives facilitates the creation of new applications that are implemented in a studio style setting. Consequently, students’ explorations of process-based applications generate LI’s that are relevant to the course objectives. The LI’s produced are the main educational criteria to be learned, debated, and utilized for developing future course concerns. This cycle allows more updated issues to be involved in coursework by developing and utilizing the research and analytical skills of students under the guidance of the instructor. Process-based design applications should therefore allow students to examine the design process in stages and make easy for them to assess up-to-date course concerns.

![Figure 1: Framework for studio-style coursework. (Source: Author.)](image-url)
Process-based Design Applications

Based on the above framework, the following includes a description of three design tasks applied through three consecutive years. The objective of this course is to enhance students’ ability to critique and evaluate different design methodologies used in design practice. Accordingly, and as discussed above, the design applications aim to subject students to study specific course objectives by being more aware of the process leading to the finalized design product. Therefore, the design applications are given to students to follow a design method or to create their own design approach and overcome the design constraints. Models are therefore used and act as simulations of the design process.

In order to facilitate for students to differentiate between the constraints, the students were given a limited number of constraints. As discussed above, the applications were kept simple and somewhat ill-structured to create a typical design challenges. However, for students at later stages of design education, the level of difficulty can be increased by raising the number of constraints and the complexity of the objectives.

Each of the three applications described below involve students in determining individual design factors influencing the overall design process. Consequently, students are required to work collaboratively in groups to identify the specific design constraints. They are then required to formulate a sequential map representing the progression of the various stages of decision-making and the overall design process. The students are given four weeks before revealing their designs and maps. This is followed by in-class debate and assessment of the final designs. Simultaneously and throughout these weeks I present lectures including visuals on different design and conceptual approaches applied in design practice.

Design Application I

The first design application was derived from Lawson as a basis for investigation (Lawson, B. 1999). The objective involves separating a total of nine marbles into three containers. The three containers had to contain two marbles, three marbles, and four marbles respectively, which created an initial sense of puzzlement regarding the strategy used for separating the marbles. After the four weeks had past, each group brought their model for testing in-class in the presence of students and instructors. Students were free to explore the use of any materials, which in turn influenced the efficiency of their models. The differences between the models varied in the way they were separated into the containers (figure 2). The following observations are highlighted:

Students’ collective evaluation of this application depended on the efficiency and ease of separating the marbles. The students found little reason to base their evaluations according to visual appeal as the task did not involve form-making as an objective. Therefore, their final models were in sole response to the design constraints and to the given puzzlement. Some of the models failed in working efficiently and were clearly devaluated by the students during their in-class evaluation.

Learning Issues: Students realized that the efficiency of the materials used in the models
was the basis for the more successful designs. The more successful models were more stable and involved smoother surfaces, which in turn became the basis of the evaluation. This led them to conduct research and experiment with the stability and surfaces of different materials. The diverse solutions produced from the same objectives highlighted that different design products can be achieved by the various ways their designs responded to the design constraints.

**Design Application II**

The second design application was applied in the following year. This task “constrained” students to using paper for bridging a given span while carrying a load at the middle. In this case the design constraints were in the restriction to using paper as the sole modeling material. Paper was therefore required to span 40 cm (16 inches) while carrying an external load of 1kg (35 lb) midway along the span. The use of adhesives in their models was forbidden and therefore raised the level of difficulty. This task limited students to experiment with the paper, however the design solutions where diverse as they differed by way of connecting the various parts of their paper structures.

All groups rolled, folded, and pierced paper to create holes and grooves in order to connect between the structural components of different sizes. One other group used paper strips to weave and tie the parts of paper using knots. Each paper bridge was tested in class and evaluated by all students (figure 3).

Collective evaluations relied on the models’ capability to carry the required load. However, the students discriminated between all the successful models by the innovative methods used to connect the paper components. In summary, their evaluations focused on structural methods used, components and their ability to create strong connections using paper.
Issues. Preconceived structural solutions were produced in the form of frame structures and beam-like reinforcements. This suggests that their final models could have been influenced by the formal composition of frame structures, which the students had previously studied in lectures on structures. This gave reason to their research on various structural systems and allowed them to explore the possibility of molding paper into these systems. Furthermore, being limited to using paper and prohibiting the use of adhesives encouraged them to explore and produce diverse methods to connect between the structural components.

**Design Application III**

In the third design application I increased the level of complexity by including multiple design constraints that seemed to conflict with each other. This application involved the design of a surface with a ratio of 1:3 between length and breadth with the objective of overcoming four main design constraints. The first is to shade not less than half of its own surface area with light perpendicularly projected upon it. Secondly, it should endure an air current being directed towards it from one direction. Third, the surface should shelter from falling water. The fourth constraint involved raising the surface above the ground level to a height not less than its own breadth. This constraint was given to restrain students from attaching their models to a stable surface as an easy solution to overcome the wind constraint.

The constraints were initially perceived by the students as being at conflict with each other. For example, in order to withstand the air current, the surface had to be tilted to avoid collecting air currents that might cause instability to the model. Simultaneously, the surface had to shade an area not less than half its own surface area, so the surface could not be completely tilted. In this case both design constraints where in conflict. Likewise, in order to protect the surface from
falling water, it had to be positioned to slope at an angle. If the surface area sloped too much, then it would conflict with the required area to be shaded.

Compared to the previous assignments, I requested from the students to produce not less than three design alternatives followed by choosing the most appropriate alternative of the three after in-class examination. Furthermore, this assignment involved more design constraints at a higher level of complexity to compensate for the freedom given in choice of materials. The evaluation of this assignment differs from the earlier ones as it involves the evaluation of not less than three design proposals from each group and accordingly took more time to evaluate. Furthermore, the evaluation process was relatively more interesting for the students as each model was examined for four constraints simultaneously: water shelter requiring the examination of form fluidity and the surface materials to protect from falling water; wind endurance requiring structural endurance to the air current inflicted upon the model; the ability to shade from light perpendicularly projected upon it; and measuring the appropriate height to which the surface is raised (see figure 4).

In order to test for wind endurance, students positioned their models in the most appropriate direction to withstand the air current created by a fan. Likewise, an overhead lamp was also used to measure the surface area of shade from light. Finally, sand was sprinkled on top of the models to test for water shelter and fluidity of form and surface materials. The use of sand as an alternative to water was a dry and quick in-class method to examine the sheltered area required.

For the students this application represented a structure that had to simultaneously overcome environmental constraints: rain, sun, and wind. Although this was not the main reason behind this assignment, however, being closer to a realistic situation facilitated the formulation of well-defined evaluative criteria. In this case the evaluation was based on overcoming these constraints collectively and efficiently. The majority of students agreed that the final form of the models was intriguing and the most dynamic and distinctive forms of the models where evaluated highly.

This application received more interest from the students as they produced more solutions to the same puzzle. In this case most of the student research was experimental and students created more than the required models, which were all tested in class. The student groups that created more testing models produced diverse design solutions than their counterparts.

Furthermore, this application made clear to the students that diverse solutions are produced from several seemingly conflicting design constraints. The additional models they created stimulated more in-class discussions relating to durability and fluidity of materials, structural systems and components in addition to the models' visual appeal. This further raised environmental concerns specifically relating to the movement of sun and airflow. In this case, the learning issues produced were based in theory and methods of investigation, which where valuable to junior architectural students.

During the first year I had requested the work groups to produce only one final design to tempt students to take final decisions. However, by
the third year I had encouraged each group to submit not less than three design proposals and to choose their most successful model in an in-class debate. This created a platform for discussing the individual attributes leading to the success/failure of their models in addition to giving justification to the evaluation. This established transparency in the evaluation and involved students in choosing the relevant criteria for evaluation. The final grading took place in class according to student and faculty votes following the application’s guidelines and objectives.

**Conclusion**

In contrast to teaching predetermined design approaches to different building types in a lecture-based format, this course subjects students to the design process in studio style. It is an attempt to overcome the “schizophrenic duality” between the creative thought provoking studio and the tedious nature of the lecturer (Maitland & Cowdroy 2001). Here, junior students are involved with the various stages of the design process providing them with greater autonomy to their education. The models allowed students to experiment with the process of design and raise learning issues derived from their own experimentation and research. The assignments facilitated for the students to link theoretical course concerns with design applications—one of the main objectives of a studio-style environment. Within this educational context students acquired a higher awareness to the individual design stages and gave clear descriptions of the design constraints and the methods used to overcome them.

One of the main points that students highlighted was that the design process did not occur in sequence, rather it gradually filtered unnecessary information by rethinking earlier design stages. As the assignments were experimental, students confirmed that the design process was not at...
all linear requiring frequent reassessment of the gathered information. This makes clear that design training is better experienced as a process than being informed in stages.

The complexity of the design constraints varied throughout the three design applications. Within application III, I intentionally included more design constraints and raised the level of difficulty. In response, students agreed that it simulated realistic design concerns and was more motivating than the earlier assignments. Accordingly, more positive results can be achieved by simulating more complex concerns by using a process-based design application. This suggests that a studio style course may include more elaborate theoretical discipline areas within design assignments.

Overall, the students’ responses were more positive in contrast to the previous course and as a result students cooperated, increased social interaction, depended highly on intuition and gained negotiation skills for final in-class decisions. Each group produced multiple solutions to a single problem and derived potential knowledge from a number of other discipline areas. This teaching approach aims to encourage students to examine theory to reach their own theoretical stance and to further be able to critique theory. As a result of the learning issues raised from their models, this teaching approach limited my involvement to developing new process-based assignments. In turn, theoretical course concerns became more open ended, absorbing new learning issues that may have been previously neglected.

This article suggests that a process-based learning approach should be motivating, intellectually challenging, and include puzzling design assignments. This can be achieved by substituting well structured problems with ill structured ones that are not faced in everyday life. Simultaneously, the problems should also be authentic and well grounded within students’ abilities. A process-based education aims to reduce instructor bias by leaving students to investigate for themselves the immediate learning issues within the course. Rather than being taught theory, students become more able to critique theory through their own investigations. This in turn brings up relevant learning issues that are often neglected in design studios that follow the master-apprentice model. The process-based assignments and studio-style approach provided students with an experimental space for design.

We are therefore in urgent need for studio training that instantly allows students to test the successes and failures of their designs. This requires involving more sophisticated technologies in a studio-style setting. Moreover, it is a fundamental requirement for undergraduate students to be trained on how to use more complex research and investigative skills. Accordingly, future students are required to gain knowledge using experimental methods and become self-directed investigators, a skill that cannot be acquired from master-apprentice models or be derived from lecture-based courses. Although teaching coursework in studio style requires further exploration, the design process is presented in this article as the tool to synthesize advanced theoretical issues into the design studio. Architectural design schools are therefore required to create a basis for an applied design studio that is integrative of the diverse areas of architecture. The stimulating and enjoyable nature of this course fostered many teaching goals that were previously
non-existent in lecture-based coursework. As a result I have become more of an advocate for integrating theory into studio teaching and further encourage employing design process-based assignments as a tool for teaching studio-style coursework.

References


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