APPLYING LEARNING METHODS WITH ARCHITECTURE STUDENTS TO IMPROVE INDOOR QUALITY FOR HEALTH AND WELLBEING IN BUILDINGS CASE STUDY: ENHANCING LIGHTING EFFICIENCY OF PUBLIC SPACES

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Abstract
The teaching-learning methods and techniques that can be applied in architecture are various, such as project-based learning, problem-based learning, research-based learning, problem-solving, simulation-based learning, designbuild and others. The researcher aims at experimenting and applying such methods in a design class at Faculty of Architecture to manage and improve the environmental quality of the public spaces that will increase the awareness of health and wellbeing aspects of the students. Therefore, the study aims to produce a new methodology for integrating different teaching-learning methods in the interior design course and evaluate the outcomes of the students according to the indoor lighting performance. The case study is based on a real problem in a realistic situation - City Complex Shopping Mall in Tripoli, Lebanon - in which the instructor and the students will analyze and measure the intensity of lighting within the mall atrium, and the extent of its reflection on the validity and functional efficiency of the building. The students with the aid of their instructor will use the Testo Light Meter/Logger and the Echotect Analysis 2010 Software as tools of measurement, simulation and development. The paper proposes successful methods to achieve special criteria for developing indoor quality to increase health and wellbeing aspects of building in general, and produce solutions for improving lighting efficiency of public spaces in particular. Through integrating different teaching-learning methods, the instructor develops and integrates appropriate techniques that will help in monitoring, improving and achieving optimal outcomes of the students’ designed proposals, thereby ensuring high educational performance.

Keywords
Learning Methods, Architecture, Indoor Quality, Lighting Efficiency, Education Performance

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CASE STUDY: ENHANCING LIGHTING EFFICIENCY OF PUBLIC SPACES

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ABSTRACT: The teaching-learning methods and techniques that can be applied in architecture are various, such as project-based learning, problem-based learning, research-based learning, problem-solving, simulation-based learning, design-build and others. The researcher aims at experimenting and applying such methods in a design class at Faculty of Architecture to manage and improve the environmental quality of the public spaces that will increase the awareness of health and wellbeing aspects of the students. Therefore, the study aims to produce a new methodology for integrating different teaching-learning methods in the interior design course and evaluate the outcomes of the students according to the indoor lighting performance. The case study is based on a real problem in a realistic situation - City Complex Shopping Mall in Tripoli, Lebanon - in which the instructor and the students will analyze and measure the intensity of lighting within the mall atrium, and the extent of its reflection on the validity and functional efficiency of the building. The students with the aid of their instructor will use the Testo Light Meter/Logger and the Echotect Analysis 2010 Software as tools of measurement, simulation and development. The paper proposes successful methods to achieve special criteria for developing indoor quality to increase health and wellbeing aspects of building in general, and produce solutions for improving lighting efficiency of public spaces in particular. Through integrating different teaching-learning methods, the instructor develops and integrates appropriate techniques that will help in monitoring, improving and achieving optimal outcomes of the students' designed proposals, thereby ensuring high educational performance.

KEYWORDS: Learning Methods, Architecture, Indoor Quality, Lighting Efficiency, Education Performance

1. INTRODUCTION

Active learning enhances the students’ knowledge and understanding of the course content (Anderson & Adams, 1992). For this reason, students who frequently encounter active learning in their courses perceive themselves not only as passive learners who gain knowledge and understand from their course work, but they are more likely to view their academic experience as personally rewarding. Moreover, students who frequently experience active learning in their classes may also have more time available for participation in academic social communities because they feel that they are able to spend less time on course preparation and studying for examinations (Milem & Berger, 1997). On the other hand, students who infrequently experience active learning in their courses may become socially isolated, in order to exclusively improve their academic performance in their courses. Hence, developing friendships and networks through active learning course activities could also assist students in establishing a certain identity in the social communities of their universities. Consequently, practicing active learning may directly influence social integration and indirectly affect institutional commitment and student departure decisions (Braxton, Milem & Sullivan, 2000).
2. METHODS OF LEARNING

Active learning methods are specific educational techniques that are related to the skills of the instructor(s) and the way they deal with the students. Through active learning techniques, students can produce wide variations in quality and educational objectives that can be achieved, such as project-based learning, problem-based learning, research-based learning, problem-solving, simulation-based learning, design-build, etc.

2.1 Project-based learning

Project-based learning is an individual or group activity that goes on over a period of time, resulting in a product, presentation or performance. It usually has certain timelines, milestones, and other aspects of formative evaluation of the project (Donnelly & Fitzmaurice, 2005). Furthermore, project-based learning differs from traditional project in adopting a multidisciplinary, project-based approach by utilizing real world problems in order to bring together knowledge and skills (as shown as Fig. 1).

![Fig. 1: The traditional project vs. project-based learning](https://studentsatthecenterhub.org/resource/projects-vs-project-based-learning-what-is-the-difference/)

2.2 Problem-based learning

Problem-based learning is both a curricular and a procedural approach. On one side, the curriculum consists of carefully selected and designed problems that requires from the learner acquisition of critical knowledge, problem-solving proficiency, self-directed learning strategies, and team participation skills (Donnelly & Fitzmaurice, 2005). The process replaces the commonly used systemic approach by resolving problems or by meeting challenges that are encountered as an independent learner and reflective practitioner (as shown as Fig. 2).

![Fig. 2: The problem-based learning process](http://www.slideshare.net/kategukeisen/problem-based-learning-basics)
2.3 Research-based learning

Research-based learning can roughly be summarised in the relationship between the approaches of enquiry / inquiry-based learning and the features of undergraduate research. As a result, research-based learning can be seen as an umbrella term, "covering a range of approaches to learning that are driven by a process of enquiry" (Hutchings, 2007). For this reason, it would include problem-based learning, project-work, field-work, case studies, etc. Thus, it is much more than only following the essential components of the traditional undergraduate research that only entail certain strategies (as shown as Fig. 3). Because research-based learning implies a stronger relationship with the methodological basics of knowledge-making ways more than enquiry-based learning, and can extend beyond the undergraduate curriculum, the instructors choose to frame their work in such a method. (Healey & Jenkins, 2009).

![Fig. 3: The research-based learning strategy](http://wilkes.discoveryeducation.com/suehellman/2010/05/12/513-week-1-inquiry-vs-project-based-learning/)

2.4 Problem-solving

Problem-solving involves a variety of cognitive components, such as propositional information, concepts, rules, and principles (domain knowledge). Moreover, it involves structural knowledge (information networking, semantic mapping / conceptual networking, and mental models), applicative skills (constructing / applying arguments, analogizing, and inferencing), and metacognitive skills (goal setting, allocating cognitive resources, assessing prior knowledge, assessing progress / error checking). Furthermore, problem solving entails motivation / attitudinal components (exerting effort, persisting on task) and certainly requires knowledge about self (articulating prior knowledge, articulating sociocultural knowledge, articulating personal strategies, and articulating cognitive prejudices / weaknesses) (Jonassen, 1997).

Problems are usually defined by a problem domain, a problem type, a problem-solving process, and a solution. First, the problem domain consists of the content (concepts, rules, and principles) that defines the problem elements. Next, the problem type describes the combination of concepts and rules and the procedures for acting on them in order to solve the problems. Then, the problem-solving process depends upon the problem solver's understanding and representation of the type problem, including an understanding of the problem state and goal state. Finally, the solution is defined. These, along with a set of operators for moving from the initial state to the goal state are known as the problem space or problem schema (Wood, 1983).

The problem space is "the fundamental organizational unit of all human goal-oriented activity" (Newell, 1980, p. 696). With practice, problem solvers construct richer problem representations or schemas that can be applied in a more procedural or autonomous manner. Therefore, experts differ from beginners because their problem schemas enable them to better recognize a problem situation as belonging to a certain class of problem. Beginners, on the other hand, possess deficient problem schemas; hence, they are not able to recognize problem states because they have to rely on generalized problem-solving strategies (Sweller, 1988). The solution to the problem whether convergent (a single, known solution), or divergent (one of several acceptable solutions) represents the goal of the problem solver. In this process, the learner must identify not only the nature of the problem, but also an acceptable solution, and a process for arriving it because the solution to the problem is not readily apparent or specified in the problem statement (Jonassen, 1997).

For this reason, using creativity or lateral thinking could be necessary to find solutions for the problem. The following are five fundamental steps of the problem solving process (as shown as Fig. 4):
1. Defining / evaluating the problem.
2. Managing the problem.
4. Resolving the problem.
5. Examine the results.

![Fig. 4: The five fundamental steps of problem solving process](image)

Reference: Updated by the author

2.5 Simulation-based learning

Simulation-based learning techniques, tools, and strategies can be applied in designing structured teaching experiences, and are used as a measurement tool linked to targeted teamwork competencies and learning objectives. It has been widely applied in the fields of aviation, military and medicine. Simulation-based techniques can offer a good scope for the training of interdisciplinary teams. For this reason, teamwork training conducted in the simulated environment may offer an additional value to the traditional learning process, enhance performance, and possibly help reduce errors (Lateef, 2009). Moreover, simulation-based technique is not only a tool for learning and training but also a tool for assessment. The skill requirements that can be enhanced with the use of simulation-based include (Gupta, Peckler & Schoken, 2008):

1. Technical and functional expertise training.
2. Problem-solving and decision-making skills.
3. Interpersonal and communications skills or team-based competencies.

The main components of simulation-based training are (as shown as Fig. 5): performance history / skill inventory, tasks / competencies, training objectives, exercises / events (curriculum), measures / metrics, and feedback and debriefing (Salas, Wilson, Burke, & Priest, 2005).

![Fig. 5: The components of simulation-based training](image)

Reference: [http://qualitysafety.bmj.com/content/qhc/11/2/119](http://qualitysafety.bmj.com/content/qhc/11/2/119)
2.6 Design-build

Design-build is a learning method of project delivery that enables the students to work individually and complete a project by integrating the roles of the designer and the constructor. To illustrate, the design-build team works under a single contract with the project owner to provide design and construction services. One entity, one contract and one unified flow of work from initial concept through completion (Molenaar, Songer & Barash, 1999). In other words, design-build aims to interrelate the creative design ideas with the construction methods and uses "learning by doing". Thus, this method motivates the students/ architects replace the traditional design-bid-build method by design-build technique (as shown as Fig. 6), which will help in avoiding problems and improving their skills.

![Design-Build vs Design-Bid-Build](http://designbuildnewsstg.hwaxis.com/wp-content/uploads/2014/04/DB-vs-DBB-flow-chart_Owner.gif)

Finally, lecturing is without any doubt an effective informational transfer, but if instructors want to develop the thinking skills of the students, problem-solving abilities and lifelong learning skills, student-centered approach (student-based learning) must be followed. This method involves a change in the role of the instructor(s) from providing information to students to facilitating and guiding learning. The importance of the student-based learning method lies in enabling the students to learn with and from each other because "learning from other people is the most instinctive and natural of all the learning contexts we experience" (Race, 2001). Moreover, the group discussion allows students to better interpret the meaning through interaction on a particular topic. It has been argued that in higher education today students must be supported to facilitate developing specific expertise and knowledge, "the skills necessary for employment and for life as a responsibility citizen" (Fallows & Steven, 2000).

In the context of group learning, students are facilitated to develop basic skills such as communication and teamwork. Where, student can only proficient a skill through its practices, also in the context of collective learning, students can learn how to work in groups, listen and negotiate with others to solve problems. These are very important skills for students to develop, as researches indicates that employers worldwide preferred graduates who have well-developed communication, teamwork and problem-solving skills (Donnelly & Fitzmaurice, 2005). However, many students want to be given the solutions rather than taking responsibility for finding information and discussing it. Thus, the realization of these learning methods depends on specific educational techniques related to skills of the tutor(s), and the methods of dealing with students to lead and facilitate group discussion, which can produce wide variations satisfactorily in the quality and educational objectives that can be achieved (as shown as Fig. 7).
3. METHODOLOGY

The experiment depending on a systematic methodology via project-based learning for a realistic project (public space), in collaboration with problem-based learning as the act of defining a problem (aspects that can negatively affect the validity of public spaces and its functional efficiency); determining the cause of the problem (the ineffectiveness of any of these aspects); identifying, prioritizing and selecting alternatives for a solution (developing environmental indoor quality of this public space); and then implementing the solution (students’ projects final submission), associated by other active learning methods, such research-based learning and simulation-based learning as an integral part of project-based learning technique.

The project was conducted in Beirut Arab University, Tripoli branch, Lebanon (developing indoor public spaces in shopping malls - using Testo Light Meter/Logger and Echotect Analysis 2010 Software as tools of measurement and development). The experiment was on a mandatory course (Interior Design) for Faculty of Architecture - Design & Built Environment students. The sample were 41 of the 3rd level students that attending the spring semester, academic year (2016-2017).

4. CASE STUDY

For the purposes of this paper, the researcher is considering the group activity involved in collaborative project-based learning, as part of Architecture students' education in Beirut Arab University on a particular course (Interior Design, 3rd year students). Specific intervention will be implemented to improve an indoor quality of public space (City Complex Shopping Mall in Tripoli, Lebanon), which will increase the awareness of health and wellbeing aspects for the students and expose them to a real problem in a realistic situation.

4.1 Phase I (project-based learning)

The semester came with single project and out of 14 weeks, and the course was delivered through several lectures intervened / overlapped the project submissions, which relevant to the university Curriculum (as indicated in Table 1).
Table 1: The outline of interior design course

Reference: The author

<table>
<thead>
<tr>
<th>WEEK</th>
<th>STAGE LABEL &amp; DESCRIPTION</th>
</tr>
</thead>
</table>
| 1    | **LECTURE:** INTRODUCTION, COURSE OVERVIEW AND INTERIOR DESIGN PROCESS; ANALYSIS, SYNTHESIS AND EVALUATION  
      **STARTING PROJECT:** DEVELOPING OF CITY COMPLEX SHOPPING MALL  
      **RESEARCH:** SITE ANALYSIS AND INFORMATION GATHERING |
| 2    | **RESEARCH SUBMISSION:** CASE STUDY, DATA COLLECTION AND ANALYSIS |
| 3    | **LECTURE:** INTERIOR SPACE; SPACE, SPATIAL DIMENSION, SPATIAL TRANSITIONS AND SPATIAL ELEMENTS  
      **PROJECT:** DESIGN PRINCIPLES; PLAN, SECTION AND ZONING |
| 4    | **LECTURE:** INTERIOR SPACE PROGRAMMING; DETAILED ANALYSIS REQUIREMENTS, ACTIVITIES REQUIREMENTS,  
      **DEVELOPING THE CONCEPT TO MATURE DESIGN:** PLAN AND SECTIONS |
| 5    | **LECTURE:** SCHEMATIC DESIGN OF INTERIOR SPACES; RELATIONSHIP DIAGRAMS, BUBBLE DIAGRAMS, SPACE  
      **STUDIES, BLOCKING DIAGRAM AND SCHEMATIC DESIGN PRESENTATION GRAPHICS**  
      **DEVELOPING THE CONCEPT TO MATURE DESIGN:** PRE-FINAL SUBMISSION - PLAN |
| 6    | **PROJECT PART 1 SUBMISSION - POSTER PRESENTATION:** LAYOUT + MASTER PLAN(S) + CEILING PLAN(S) |
| 7    | **LECTURE:** INTERIOR DESIGN PRINCIPLES; PROPORTION, SCALE, BALANCE, HARMONY, UNITY AND VARIETY,  
      **RHYTHM AND EMPHASIS** |
| 8    | **LECTURE:** ELEMENTS OF INTERIOR DESIGN; FORM, SHAPE, TEXTURE, COLOR AND LIGHT |
| 9    | **LECTURE:** COLOR IN INTERIOR DESIGN; BASIC OF COLOR THEORY, COLOR CONTEXT AND COLOR SCHEMES  
      **PROJECT PART 2 SUBMISSION - POSTER PRESENTATION:** SECTION(S) + ELEVATION(S) + MATERIALS + FULL PROGRAM |
| 10   | **LECTURE:** LIGHT IN INTERIOR DESIGN; LIGHT, GOALS OF GOOD LIGHTING DESIGN, SUNLIGHT AND DAYLIGHT,  
      **ARTIFICIAL LIGHT SOURCES, LIGHT FIXTURES, METHODS OF LIGHTING / ILLUMINATING THE SPACE AND CASE STUDIES** |
| 11   | **PROJECT PART 3 SUBMISSION - POSTER PRESENTATION:** RETAIL SHOP SAMPLE (PLAN, CEILING PLAN,  
      **SECTION(S) AND EXTERIOR ELEVATION) + SKETCHES + DETAILS (FURNITURE, COLOR SCHEME AND LIGHT FIXTURES / THEME)** |
| 12   | **LECTURE:** INTERIOR FINISHING MATERIALS; SELECTING CRITERIA, FLOORS FINISHING, WALLS FINISHING,  
      **CEILINGS FINISHING AND COMMON ARCHITECTURAL MATERIAL DEVELOPING THE DESIGN** |
| 13   | **LECTURE:** FURNISHING IN INTERIOR DESIGN; FURNITURE STYLES / SCHOOLS, HUMAN FACTORS AND FURNITURE  
      **LAYOUT**  
      **PRE-FINAL SUBMISSION - FULL DRAWINGS** |
| 14   | **LECTURE:** SAMPLES OF FINAL PRESENTATION PROJECTS / DRAWINGS  
      **PROJECT PART 4 SUBMISSION - FINAL POSTER PRESENTATION:** DRAWINGS + PERSPECTIVES + INTERIOR FORM  
      **GENERATION STUDIES + FINAL PHYSICAL / DIGITAL MODEL"OPTIONAL"** |

### 4.2 Phase II (research-based learning)

The case study is based on a real problem in a realistic situation, in which the instructor with the third year students divided into three groups study and analyze the benefits of atriums on public spaces, particularly; shopping malls, types of atriums and its characteristics, types of skylights, factors that affect the natural lighting, how to control the light that is penetrating the atriums, the artificial light, the physics of light and the ideal intensity of lighting within the mall atrium. In addition, different floor finishing, walls and ceiling finishing, interior design principles and elements of interior design (as shown as Fig. 8).
Then, the instructor and the three participant groups began to study and analyze different case studies of shopping malls, atriums, skylights and their decorative elements, also the importance of colors and how it effect on public spaces, fire safety for atriums, role of atriums and the different shapes of atriums (as shown as Fig. 9).
4.3 Phase III (problem-based learning)

Therefore, based on the previous research, the instructor with the students began to analyze the aspects of the problem that may affect the validity of public spaces in general, such as atrium various problems, problems of skylight and interior spaces spatial dimension, transition and elements, etc. Accordingly, the study particularly examines the strength and weakness of the project (City Complex Shopping Mall) in terms of the previous aspects. Thus, the students determined the cause for the ineffectiveness of the environmental indoor quality that negatively affects the health and wellbeing and consequently the functional efficiency within the study public space, and then realized that it is mostly represented in the intensity of the lighting inside the shopping mall atrium (as shown in Fig. 10).

Subsequently, the instructor with the students start to measure and analyze the scope of the problem; the intensity of lighting within the study project (City Complex Shopping Mall) atrium, and to determine the extent of its impacts on the validity and functional efficiency of the building performance, through using Testo Light Meter/Logger from the Faculty environmental lab as a realistic measurement tool, and by dividing the basement, ground and first floor of the mall atrium with a module grid 2x2m, while taking measurements at each of the focal points in the grid specific hours during the day (as shown as Fig. 11), to indicate the deficiency and efficiency locations in the lighting intensity throughout the surrounding space area and corridors in front of mall shops.
4.4 Phase IV (simulation-based learning)

Initially, the instructor / facilitator presents a brief about the simulation topics and their most important concepts and explain the simulation-based method to the students. In addition, the instructor guided the students and explained how to organize the work of each group as well as the methods and equipment used in simulation. Then, the students participate in the simulation, whereas the instructor guides and monitors the students’ performance to proceed and emphasize the extent of the problem, by measuring and analyzing the intensity of lighting within the project (City Complex Shopping Mall) atrium. Through using Echotect Analysis 2010 Software as a simulation measurement tool, and by taking measurements at each of the same focal points in the grid that have been divided for the basement, ground and first floor of the mall atrium, and at same specific hours during the day (as shown as Fig. 12), the instructor motivates and assists the students for the feedback and debriefing to confirm the deficiency and efficiency locations in the lighting intensity throughout the surrounding space area and corridors in front of mall shops.

![Fig. 12: The lighting intensity measurements simulated by Echotect Analysis 2010 Software](image)
Reference: Updated by the author & participant students

4.5 Phase V (results)

The students with the aid of their instructor, worked on special design criteria for development the indoor environmental quality to achieve health and wellbeing aspects in public spaces, specially, within the study project (City Complex Shopping Mall). In addition, the participants created solutions for improving the lighting efficiency inside the mall atrium by increasing the light intensity in low lighting places and decreasing it in ultra-bright lighting places. Through certain modifications in the skylight to control the natural light and with the assistance of artificial lighting (as shown as Fig. 13), the participants were able to resolve the problem.

![Fig. 13: Samples of the projects final submission](image)
Reference: Supervised by the author and updated via the participant students
5. CONCLUSIONS

Realistic projects embody characteristics that give feeling of authenticity to students. The characteristics can include the topics, tasks and roles that students play, the context that the work of the project is carried out in, the output that are produced, or the criteria by which the performance are judged.

The architecture students succeeded in using Testo Light Meter/Logger and Echotect Analysis 2010 Software as tools of measurement, simulation and development, to achieve special design criteria for improving the indoor environmental quality in public spaces.

Applying active learning methods with architecture students enabled them to analyze the learning process, which increased their awareness of health and wellbeing aspects in buildings and possibly set new learning goals.

Project-based and problem-based learning strategies have the potential to support the development of academic knowledge and skills, which will enhance the student education performance.

Teamwork training conducted in the project-based learning environment may also offer an additive benefit to the traditional education, enhance performance, and possibly also reduce errors.

Simulation-based learning can open up a new educational application in architecture, but the cost-effectiveness of potentially expensive simulation-based learning and training should be examined in terms of improvement of interior design and its impact on architecture.

The key to success in applying active learning methods is integrating its techniques into traditional education programs to achieve optimal outcomes, thereby ensuring high education performance.

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