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APPROPRIATE TECHNOLOGY AND DESIGN-BUILD PROGRAM IN ARCHITECTURAL EDUCATION

NIHAL ABDELWAHAB AMER[1]

ABSTRACT

Architectural education may face challenges to successfully integrate appropriate technology and participatory approach in the design course program. The present work aims at clarifying the privilege of adopting the design-build program in architecture design studio and how this was achieved and fulfilled by the faculty members in architecture department in MSA University. The study has a multi-stage structure; staff perception and observation of students' performance, implementation of a questionnaire on the course program and gained experience in the different topics and activities, and the evaluation of questionnaire results. The questionnaire contains 12 topics and activities covered in Architecture Design V Fall2015, MSA University, and was delivered to 150 students. They were asked to rate the importance of the course components and their gained experience. Their perception was measured through the analysis of the questionnaire results. They were enthusiastic about dealing with residence and by the hands-on activities. This was what made the studio different than the traditional ones. Hands-on activities proved to be crucial in architecture education. There is a need to incorporate design-build program for design studios and students engagement with the community through the participatory approach. Integrating appropriate technology in architectural design studios will raise awareness for architectural students of its importance in professional practice.

KEYWORDS: Appropriate building technology – architecture design studio–design-build program - community participation.

1. INTRODUCTION

In the last few decades the environment is suffering from the recent developments in industry and technology. Using appropriate technology, AT, is crucial for enhancing and developing communities. Architects have a very important role in engaging local people, through participatory approach, PA, in utilizing the AT.

[1]Assistant Professor, Architectural Engineering Department, MSA University, Sixth October, Giza, Egypt

Architecture education has a crucial role of raising students' awareness of the importance of AT and PA in the professional practice.

The Architectural Engineering Department in October University of Modern Sciences and Arts, MSA, is concerned with the Architectural Design and improvement of integrated structural and building systems. The architectural engineering students in MSA are introduced to a broad spectrum of architectural engineering topics throughout five academic years. The architecture program consists of 54 courses with 168 credit hours. There are eight architectural design studios throughout the five academic years finalized with the graduation project in the last year. The main theme of Architecture Design V in Fall 2015 was the Appropriate Technology. The title of the project is 'Community Development Center' located in Youssef Pasha District in Fayoum Governorate. Its overall area is about 2000 meter square. The program components are initiated by students according to the users' needs and as a result of discussions with them. It mainly includes workshops, galleries, training classes, gathering area and a medical unit. Architecture Design V is four credit hours where students participated in lectures, researches, physical models, field trips, hands-on activities and design-build program.

Educators face challenges to successfully integrate AT and PA into the architectural design course program. This paper addresses how the faculty members of architecture Design V in MSA University were attempting to treat this problem by incorporating AT and design-build program in the design studio. The present work is considered as an action research since it practically assess the impact of design-build program on the students. According to Mckernan, "Action research is inquiry conducted by a practitioner to improve the quality of that practice in a social setting through the researching of action, by the practitioner, in a reflective manner"[1]. Architectural education must prepare students think and respond constructively. The successful architect combines the brainwork and the handwork using different tools such as computer, experimental models and others. The activity includes successive processes that start with an idea then a drawing, an experiment, and finally a construction.

2. PURPOSE AND SCOPE OF THE RESEARCH

A main goal of architectural education is to graduate architects who will pay special attention to environment-related issues and impacts imposed through AT uses and utilize the interaction between the user comfort and the building products through PA. This, consequently, appears in the design-build program in architectural design studio by the acquisition of knowledge about materials, construction and lessons in community services.

The main research objective is to clarify the privilege of adopting the design-build program in Architecture Design Studio. The present work aims to survey the responses of architectural students towards the current way of teaching architecture design by adopting design-build program, and to evaluate the students' sensitivity in acquiring the teaching program. In this context, a survey study was conducted to evaluate the students' gained experience of the different topics and activities included within the course Architecture Design V, Fall 2015-2016 by investigating the impact of the course program on students. Therefore, a questionnaire was designed to reflect the above-mentioned concepts in order to demonstrate the real impact of the design-build program on the overall students' gained experience. This may help the staff and program planners to understand the actual students perception about the course of architecture design that might lead to future improvement and enhancement of the teaching processes.

3. METHODOLOGY OF THE RESEARCH

The research technique applied in the present work falls into two types: observation and survey. The observation technique includes case study, records, photographic records, check lists, rating scales and field notes. The survey technique includes questionnaire and interview. The study, which focuses on students' interaction with teaching Appropriate Building Technology and Participatory Approach, has a two-stage structure, the implementation of a questionnaire on the course program and gained experience in the different topics and activities, and the evaluation of the questionnaire results.

4. APPROPRIATE TECHNOLOGY AND PARTICIPATORY APPROACH

The term ‘Appropriate Technology’ became popular in the 1970s with E.F.Schumacher’s best seller ‘small is beautiful’: economics as if People Mattered and had a significant impact at the onset of oil crisis, the emergence of globalization and the gradual development of political ecology [2]. The following definition of AT is the most relevant among some web-based definitions. “Appropriate Technologies: are technologies that require only small amount of capital, emphasize the use of locally available materials, in order to lower the cost and reduce supply problems; are relatively labor intensive but more productive than many traditional technologies; are small enough in scale to be affordable to individual families or small groups of families; can be understood, controlled and maintained by villagers whenever possible with a high level of specific training; can be produced in villages or small workshops; suppose that people can and will work together to bring improvements to communities; offer opportunities for local people to become involved in the modification and innovation process; are flexible, can be adapted to different places and changing circumstances and can be used in productive ways without doing harm to the environment” [3]. AT is one kind of technological solutions that supports environmental-related concerns in developing regions [4]. Its soft approach and resources localization mindset have been often interpreted as two important ways to promote a responsible utilization of local resources by introducing cleaner application of a technological solution based on existing circumstances [5,6]. One of AT elements considered as having high environmental impact is materials usage. Inspite of the debatable of engineering values of AT, environmental concerns in materials-related research of an AT refer to its engineering appropriateness [7].

Community participation while designing and operating neighborhoods is a key issue contributing to the success of housing projects. The participatory design is an effective tool in reaching a strongly bonded community responsible towards their living environment. The participatory design means developing the district or city by citizens’ participation in the design process. District or city has to set out some criteria to allocate the end users and select deserved citizens for the district. One of these

criteria is people readiness to establish and generate different activities in the area. Architecture students should learn how to explore the community development and contribution roles of civil institutions of the social, environmental and urban levels.

5. EDUCATIONAL PURPOSE AND MOTIVATIONS OF THE DESIGN-BUILD PROGRAM

In the field of architectural education, design-build is a teaching alternative to the theoretical, desk-based design process that is commonly featured in design schools [8]. There are many reasons for adopting the design-build program in the architectural education. This program has many advantages, some of which are discussed below.

5.1 Exposure to Construction

The main motivation of the program is to introduce students to the art of building. Students' creativity is activated and enhanced through the hands-on construction as they realize what is involved in taking architecture from a drawing to a building. It is "an opportunity for the students to understand the building process with their own physical labor – recognizing the value of hands-on learning." [9]. The building experience is student's key motivation for joining the design-build program.

5.2 Providing Service to Local Communities

Most design-build programs are organized to provide service to local service to local communities. Rural design studios send students to rural areas to design build and support the poor. The studio instructors are not just trying to help a community but they are trying to get students to be better citizens, better community advocates, and to understand the complexity of urban areas [10]. This shows that architectural practice has an ethical commitment to others. This commitment is manifested in real building and that people can use and benefit.

5.3 Exposure to Architectural Professional Practice

The design-build program exposes students to a broader range of architectural practice and engages them to all aspects of the design and construction process; dealing with clients, codes, inspectors, contractors, product suppliers, engineers and neighborhood associations. "Exposing students to all of the forces that come to bear

on the making of a building, whether environmental, technical or political, they can begin to harness them to become more effective as architects" [10].

5.4 Criticizing the Hypothetical Academic Studio Projects

It is a critique of the lack of reality found in many hypothetical academic studio projects. On the other hand, the design-build program is considered as a design activity that enriches the students' decision-making through direct-engagement. The kind of questions asked, criteria of success, basis of judgment are realistic due to the reality of the project setting. Accordingly, the design solutions are less personal and grounded valuable in a reality [11].

5.5 Being More Responsive to Specific Site and Local Conditions

The realness of design-build program gives a chance for students to be trained in a more responsive way to a specific site and local conditions focusing on the climate and local culture. The climate studies and the environmental performance of the building for natural ventilation, natural lighting and cooling are not only diagrammatic, but real. Designing in a real place challenges the students to respect and consider local architectural character, heritage and ways of life. Moreover, the experience of design-build program shows that the sources for design inspiration could be born from understanding culture and place [12]. Understanding local contexts is important for designers to produce a good building design. The context determines the architectural style, building material selection and site layout [13].

5.6 Working in Team

Design-build is a group project that benefits from diversity. It exposes students to working in teams, allowing them to grow in self-confidence in terms of working in teams and accepting that they don't have to be great at everything [10].

5.7 Exploring Building Materials

Through the design-build program, students explore the uses, characteristics and potentials within building materials. Students are engaged in both materials and processes of building.

6. STAFF PERCEPTION

The course Architecture Design V is tailored by the staff in a way that it adopts appropriate building technology and participatory approach as main themes of the Design Project. It consists of twelve topics and activities as shown in Fig. 1.

1. Appropriate Building Technology All Over the World
2. Participatory Approach & Community Participation (Field Trip)
3. Technical Visit to Faculty of Agriculture, Cairo University
4. Space Program Implementation
5. Laboratory/Workshop Activities
6. Building Construction Drawings
7. Building 1:1 Wall Bearing Model (Prototype)
8. Considering Environmental Studies
9. Site Analysis and Generation of Concept
10. Preliminary Layout
11. Contextual Layout, Plans, Sections and Elevations
12. Detailed Sections of the Appropriate Building Technology

Fig. 1.Topics and activities covered in Architecture Design V, Fall2015

The following section describes the students' performance in these topics and activities:

6.1 Appropriate Building Technology All Over The World

In the beginning of the semester the staff challenged the students work in teams to study the methods employed in the construction of the appropriate building technologies around the world. Students' studies included research through texts,

drawings, photographs, and the construction of a model representing a selected building constructed with appropriate technologies. The staff observed and felt the students' motivation while exploring the technological innovations, which are specially intended for particular sectors to fulfill specific needs of certain societies in conditions inherent to each context. These structural systems of the different AT were displayed in the exhibition of the Architectural Department, MSA, as models for all to study but the primary educational lessons came to those who constructed them. Moreover, the important practical part of the research is collecting different construction materials of the diverse appropriate technologies and fixing them on a wooden panel. Figure 2 shows some samples of the students' models.

Fig. 2. Samples of students' models using adobe and wood.

6.2 Integrating participatory Approach and Community Participation with the Design Process

The design-build program of Architecture Design V, Fall 2015 is characterized by its organization around and intention to provide service to local communities and to those in need. Architecture Design, which is considered a Rural Studio, sent students to rural Fayoum, to design and provide support to the poor. Students got engaged on a community service project by designing a community development center. They got the chance to meet some residences and the community representatives who expressed their needs and discussed their problems. Students developed their communication skills while explaining to the residences the development objective of the center, which is to improve their living conditions and economic status. The residences expressed their need in learning how to produce dairy products in a clean and hygiene way, Fig. 3.

Fig. 3. Students interacting with residences in Fayoum.

6.3 Technical Visit To Faculty of Agriculture, Cairo University

Students visited the Faculty of Agriculture, Cairo University to study practically the organization and space requirements of dairy products center, Fig. 4. The technical specifications of the spaces in terms of natural ventilation, lighting, dimension and shapes of appliances were highlighted during the visit.

Fig. 4. Different appliances in the dairy product center.

6.4 Space Program Implementation

Based on the students' participation with the inhabitants, they were able to identify the different components of the 'Community Development Center' projects according to the actual user needs. Students understood that an architect should be able to listen to people and understand them, otherwise he might simply become someone who creates architecture for his own fame and self-glorification, instead of doing the real work he has to do. Guidelines for space program implementation were presented by teaching assistants in MSA University, Fig.5.

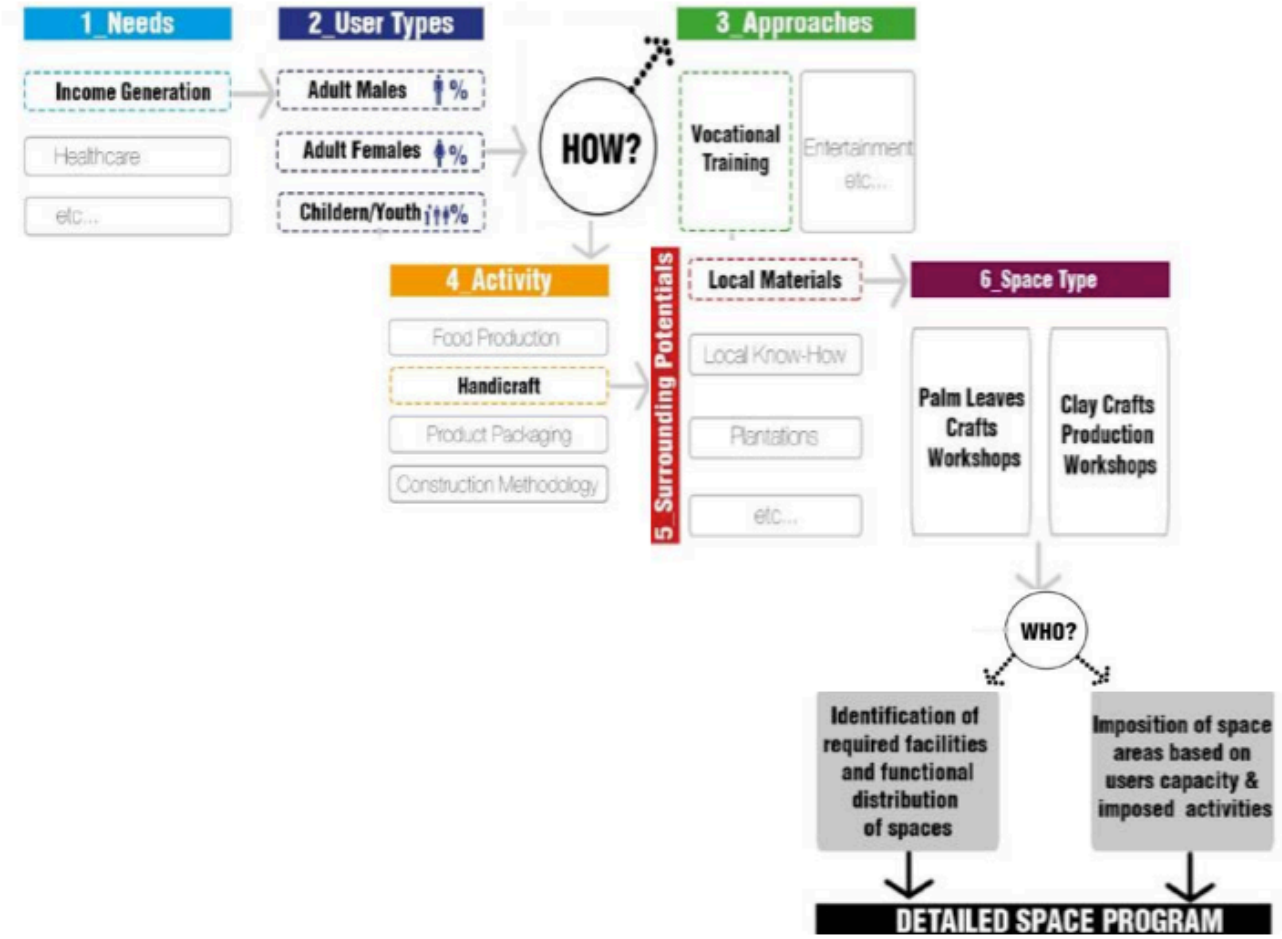

Fig. 5.Guidelines of space program implementation presented by Teaching assistants, MSA University.

6.5 Laboratory/Workshop Activities

In the workshop, students had the opportunity to explore the characteristics of the soil. They constructed small models of the rammed earth. They went through different stages: testing the soil suitability, screening the earth by removing the largest stones manually, mixing, and then putting the soil in layers inside the wooden form while ramming each layer with a small rammer as shown in Figs. 6a and 6b.

Fig. 6a. Rammed earth model in the laboratory.

Fig. 6b. Rammed earth model in the laboratory.

6.6 Building Construction Drawing, Process of Construction and Details:

Students drew the building construction drawings of domes and vaults including plans, sections, elevations and details. They also drew the different stages and processes of construction of wall bearing using the rammed earth construction, compressed earth blocks and the earth bag construction.

6.7 Constructing 1:1 Wall Bearing Model

A wall bearing structure is considered an 'appropriate technology' for Fayoum conditions. It is suitable for low-income citizens who can use locally available material that lowers the cost. It is small in scale to be affordable to individual families. Moreover, it can be understood, controlled and maintained by villagers.

An experiment was carried out in the university campus for training students. The wall bearing building is a small adobe structure having an area of 7 square meters, which was constructed in a month. The first stage of constructing a 1:1 wall bearing building began by constructing plain concrete foundation. Students started constructing the wall by building few layers of burned red bricks followed by compressed earth blocks as presented in Fig. 7.

Fig. 7.Compressed earth blocks above the red bricks.

Figure 8 shows how students continued building the 1:1 wall which was constructed by one and a half brick. Openings were designed to be in center of walls.

Fig. 8.Students constructing the wall.

By building arched walls and pendentives on the corner, students learned practically the way of constructing the dome on a squared plan through the transitional zone as shown in Fig. 9.

Fig. 9. Arches, domes and pendentives.

Applying experience gained in the laboratory of preparing rammed earth wall, students started assembling the wooden formwork to be ready for constructing the wall as shown in Fig. 10. The wooden formwork is most effective when it is small and simply designed. It must be solid and stable in order to resist the pressure and vibrations resulting from the ramming. It must be easy to manage, i.e., light and easy to assemble.

Fig. 10. Wooden Formwork for constructing Rammed Earth Wall.

6.8 Considering Environmental Studies during the Design Process

Students learned how to integrate the environmental studies into the Design Project. They practiced using soft ware program entitled "Design Consultant" to understand that there are different climatic parameters that affect their design decisions. Through the process of development, they utilized environmental strategies deduced from the program 'Design Consultant' to be implemented in their design.

6.9 Site Analysis and Generation of Concepts for the Design Project

Site visits and analysis are crucial steps in the design process. Students constructed a model showing the site and its surroundings, Fig.11. They were able to create a concept based on cultural studies of place, people and site analysis, Fig.12.

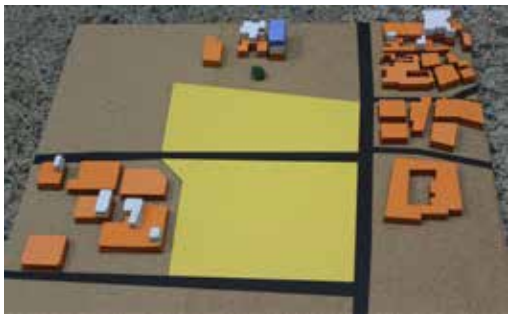

Fig. 11. Model of site and surroundings.

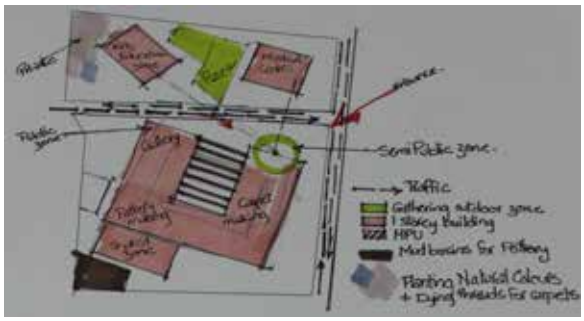

Fig. 12. Concept based on site analysis.

6.10 Preliminary Layout, Constructing a Study Model

Students began the design stage by constructing study models representing different alternatives of design concepts. They learned the importance of study models in creating the building form, Fig. 13.

6.11 Contextual Layout plans, sections, and elevations

Figure 14 shows the relationship of Community Development Center with its surroundings.

Fig. 13 Study Model

Fig. 14 Contextual Layout

6.12 Detailed Section of the Appropriate Building Technology

Figure 15 shows a detailed section of the rammed earth wall bearing which is related to the student's project.

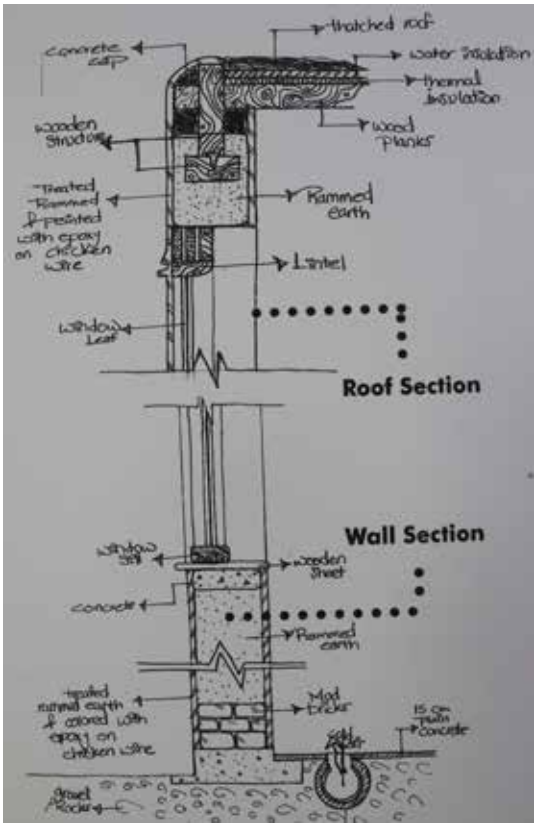

Fig. 15. Detailed section of the rammed earth.

7. STUDENTS' PERCEPTION

Students' perception is discussed in the following section showing their reflection on the course program, course contents and activities and their gained experience of the topics and activities covered in the course.

7.1 Students' Perception on Course Programs

The questionnaire was delivered to 150 students of Architecture Design V course (ASE331, Fall 2015) as hard copies and/or via e-mail. Within the scope of the questionnaire, the students were asked to rate the importance of the course components and their gained experience. Positive responses to the questionnaire were received from 103 students between 13th–23rdMarch 2016,while the rest were unwilling to answer.

The Design V Studio's intention is to adopt the design-build program to achieve its main purposes which are: construction experience; community service; larger vision of professional practice; awareness of place; upgrading collaborative skills and explore building materials. The successful interaction between the staff and the students helped to fulfill all the topics and activities listed in Fig.1. The student perception was measured through the analysis of the questionnaire results.

According to the analysis based on the item that reads "Give your evaluation on the usefulness of the overall course program" of the 103 students, 8% rated excellent, while 43% rated good, 32% rated fair and 18% rated bad, Fig. 16.

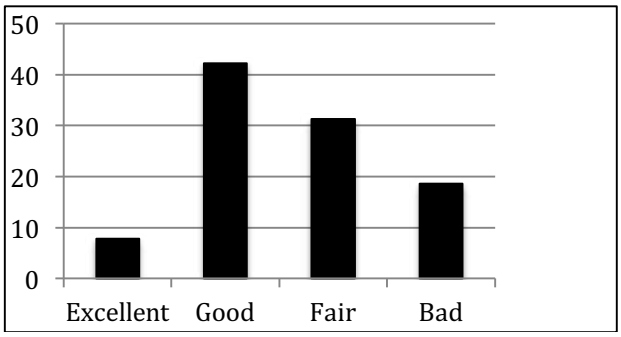

Fig. 16. Usefulness of the overall course program.

According to analysis based on item that reads "Give your evaluation on the general balance of time dedicated to lectures, exercises and field work" of 103 students, 15% rated excellent, 19% rated good, 37% rated fair and 29% rated bad, Fig. 17.

Fig. 17.General balance of time dedicated to lectures, design & field Work.

According to the analysis based on the item that reads "Give your evaluation on the sequence in which the different topics are taught" of the 103 students, 9% rated excellent, 40% rated good, 30% rated fair and 23% rated bad, Fig. 18.

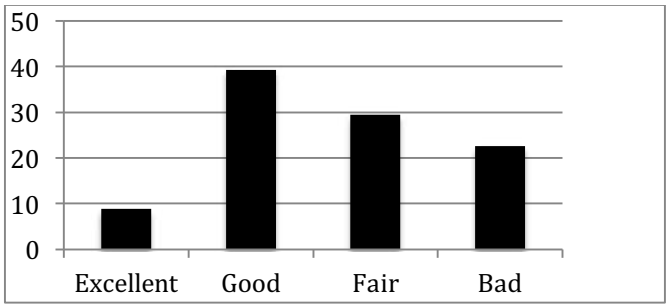

Fig. 18. Sequence in which the different topics are taught.

According to the analysis based on the item that reads "How did you experience the overall work load in the course program" of the 103 students, 7% rated excellent, 46% rated good, 35% rated fair and 14% rated bad, Fig. 19.

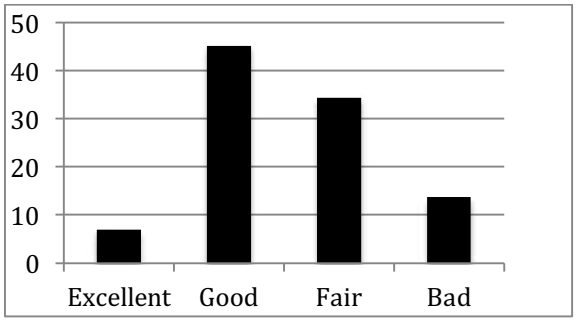

Fig. 19. Overall work load experience.

7.2 Students' Perception on Course Contents and Activities

Students were asked to choose the most interesting topic from their personal point of view. Their responses are demonstrated in Fig. 20.

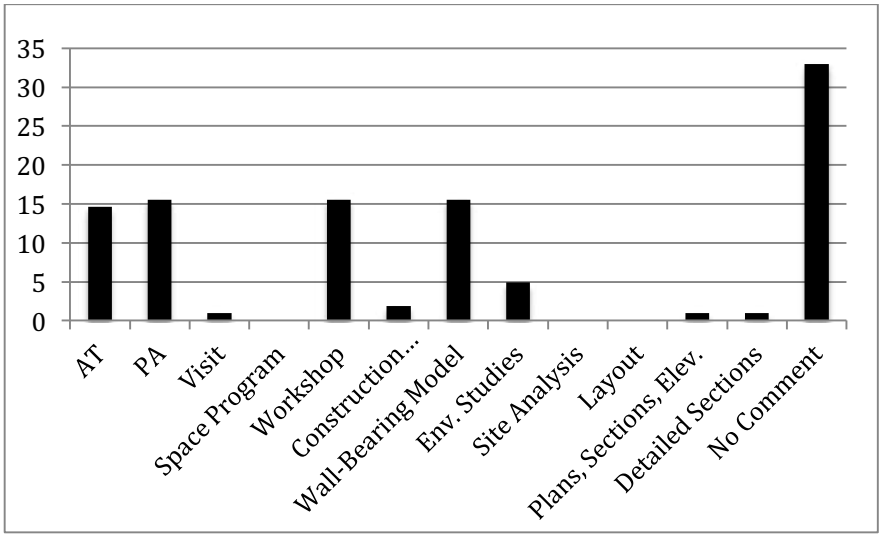

Fig. 20. Students' personal view of the most interesting course activities.

7.3 Gained Experience of the Topics and Activities Covered in the Course

Students were asked to rank the different topics and activities of the course. The detailed results are illustrated in Figs. 21-24, and showing the percentage of students giving different rankings: excellent, good, fair and bad, respectively, while Fig. 25 shows the percentage of student who did not answer. These figures demonstrate that 37% of the students gained excellent experiences in testing of materials in the laboratory, 33% of the students gained excellent experience in field trip to Fayoum and communicating with residences, 26% found that they gained excellent experience in constructing 1:1 wall-bearing model, 43% got good experience during the AT research and model, 41% gained good experience in the space program implementation and 37% gained good experience during the visit to Faculty of Agriculture. On the other hand, only 8% of the students said that they badly experienced form constructing the 1:1 wall-bearing model and 9% said that they badly experienced the testing material in laboratory.

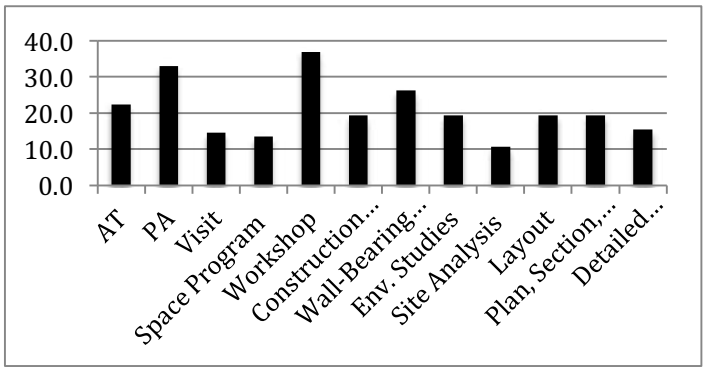

Fig. 21. Percentage of students who answered: Excellent gained experience.

The response, which received a rating of excellent, reflects the most interesting topics for the students.

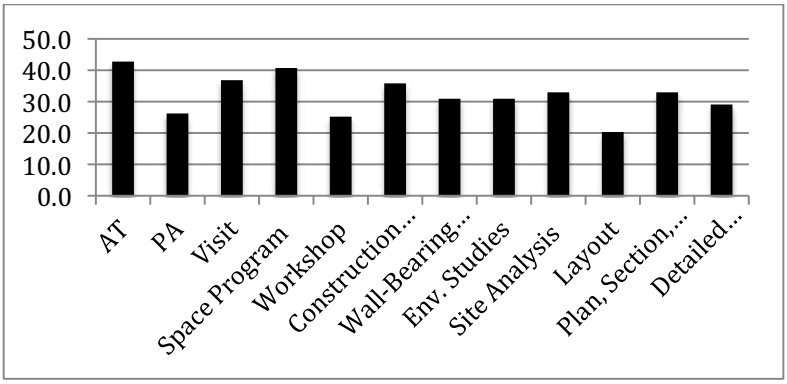

Fig. 22. Percentage of students who answered: Good gained experience

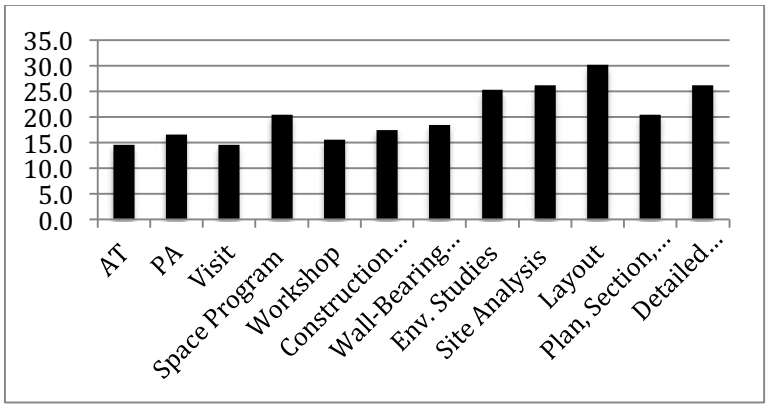

Fig. 23. Percentage of Students who answered: Fair gained experience.

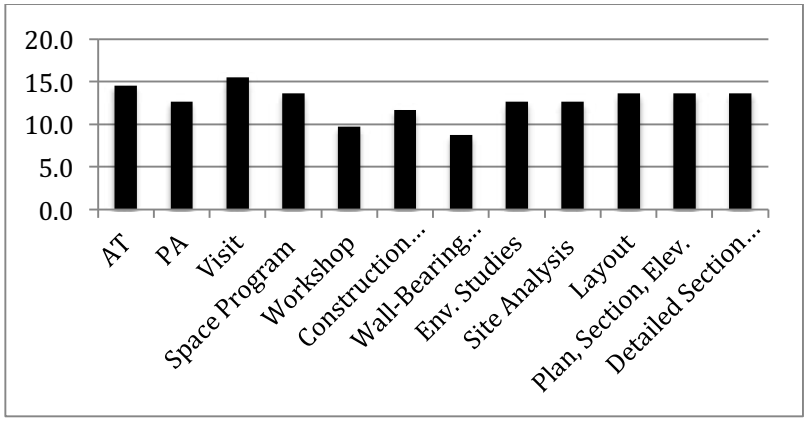

Fig. 24.Percentage of students who answered: Bad gained experience.

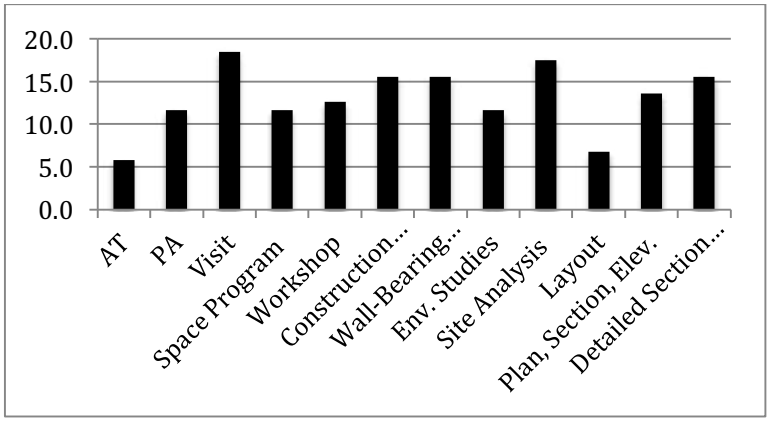

Fig. 25. Percentage of students who did not answer.

8. REVIEW AND DISCUSSION OF RESEARCH FINDINGS

The results of the questionnaire conducted to survey the responses of architectural students towards the current way of teaching architecture design could be summarized as follows. According to the questionnaire students priorities while selecting the most interesting topics: testing material in the workshop; field trip to

Fayoum and participating with the community; building 1:1 wall-bearing model and the group research. It is possible to view these findings in detail in Fig. 20. The greatest percentage of students gained excellent experience in the above mentioned topics are shown in Fig. 21.

The response, which received a rating of excellent, reflects the most interesting topics for the students. Accordingly, these topics should get more attention during the teaching process in architecture design studios.

The following is a brief summary of the most impressive comments given by the students in the questionnaire:

- "Testing materials in the workshop, hands-on activity and learning how to make rammed-earth wall from A – Z was a great experience. It was good to study AT and materials but focus on design process was not quite good."
- "Field trip to Fayoum and participating with the community are the most interesting activities. We did not show our project to the community to make sure that it is able to help the residence in the site."
- "It is very motivating to build with our hands a 1:1 wall-bearing model in the university Campus. We prefer to build a complete building on a larger scale for the community."
- "It is good to use local materials in building to reduce the cost of the project."
- "A lot of time was dedicated to the group research. Designing plans, sections and elevations need more time."
- "Within the environmental studies we greatly benefit form the weather program (Climate Consultant and Ecotect)."

9. CONCLUSIONS

Within the framework of the research conveyed in this paper, the activities and topics covered in Architecture Design V Fall2015 were assessed. Students were very enthusiastic about dealing with real residents. They were also very motivated by the hands-on activities. These what made the studio different than the traditional ones, as it is more interactive and productive.

The results of the questionnaire is a real indicator reflecting the responses of the students towards the current way of teaching architecture design by adopting the design-build program along with using appropriate technology and participatory approach. According to the results of the questionnaire it is obvious that there is a need to incorporate design-build program in design studios and the student engagement with the community through participatory approach, which are partly or completely unaddressed in the tradition way of architectural education. Inspite of the benefits and positive aspects of this experiment there are some lessons learned that can be beneficial for future similar experiments. A clear work plan must be prepared prior to any activity in order to guarantee the successful finalization of the experiment. A suitable budget should be available all the way to meet the running expenses smoothly. A land should be provided to be totally allocated for this experiment and for implementing the project. Being enthusiastic at the beginning of the project, students and residents were depressed leaving the activity without reaching the final goal: reaching the full completion of the project. On the other hand, students needed more time for the design process of the building. It is recommended for future experiments to expand the duration of design-build studios to cover two successive semesters. The first would be for the research and design, and the second for the construction stage.

Integrating the appropriate building technology theme and participatory approach within the architecture design course program should be taken into consideration. The successful story of the hands-on activities, testing and building 1:1 model prove to be crucial in architectural education since it helps to guide the future architects and designers in creating sustainable environments.

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التكنولوجيا الملائمة فى برنامج "تصميم-بناء" فى تعليم الهندسة المعمارية

يقوم قسم الهندسة المعمارية فى جامعة اكتوبر للعلوم الحديثة والآداب بتدريس مادة التصميم المعمارى. ويهتم بتحسين منظومة التشييد والبناء المتكاملة. ويتكون برنامج الدراسة من 54 مادة بعدد 168 ساعة معتمدة. وهناك عدد ثمانية ستوديو تصميم معمارى خلال سنوات الدراسة الخمس. ان التكنولوجيا الملائمة هى الموضوع الرئيسى فى مادة التصميم المعمارى V فى خريف عام 2015. ويلاقى اعضاء هيئة تدريس هذة المادة تحديات بهدف عمل تكامل ناجح بين التكنولوجيا الملائمة والمشاركة المجتمعية وبين برنامج مادة التصميم المعمارى.
ويتناول هذا البحث كيفية محاولة اعضاء هيئة تدريس هذة المادة علاج هذة المسألة. ويهدف البحث الى ايجاد محاولة تبنى برنامج "تصميم-بناء" فى ستوديو التصميم المعمارى. وفى هذا السياق تم عمل استطلاع لآراء الطلبة لتقيم مدى استجابتهم فى استيعاب برنامج الدراسة ومقدار الخبرة المستفادة من عناصر مادة التصميم المعمارى المختلفة. حيث تم توزيع 150 استطلاع اسمارة استطلاع رأى – وقد استجاب منها عدد 103 طلاب الذين اجابوا على الاستطلاع. وقد أظهرت نتائج وتحليل الاستطلاع حماس الطلاب واقبالهم على الانشطة العملية والتفاعل مع المجتمع. وقد انتهى البحث الى اهمية دمج التكنولوجيا الملائمة فى مواد التصميم المعمارى.