A Computational Design Workshop Experience for 21st Century Architecture Education

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With the rapid increase in the accessible data, available information surpasses one's ability to extract knowledge from, which puts a great emphasis on the skills of the individual to reach and use relevant information, adapt to changing conditions and sustain respective skills. ICT skills, critical thinking skills, and communication/collaboration skills emerge as the survival skills and key factors for individuals to cope with the demands of the 21st-century. It is known that educational institutions have struggles in changing the curricula/teaching system in coping with the requirements of the rapidly evolving industry. Thus, workshops gained more importance in different levels which are a part of curricular or extracurricular activities to re-furnish existing skills or gain new skills. In the scope of this study, the learning and teaching approaches based on STEAM approach are assessed through a three-day workshop aiming to illustrate how these survival skills can be conveyed and embedded into the architecture education. The workshop is designed to be inclusive for all architecture students regardless of their level of education or background knowledge/skills. Within the scope of this paper, the conduction strategies of the workshop are covered in detail to highlight the importance of these survival skills along with the modes of teaching and share the best practices and gained knowledge for future works.

Keywords: *Computational Design Workshop, Architectural Education Strategies, Survival Skills*

1. INTRODUCTION

Today, the prevalence of interactive technologies has yielded to the emergence of new learning environments in which learners expected to take responsibility and control of constructing a new medium through their own experience. With the rapid increase in the accessible data, available information surpasses one's ability to extract knowledge from, which puts a great emphasis on the skills of the individual to reach and use relevant information, adapt to changing conditions and sustain respective skills. ICT skills, critical thinking skills, and communication/collaboration skills emerge as the survival skills and key factors for individuals to cope with the demands of the 21st-century.

This dramatic change not only forces learners to

adapt themselves but also puts great pressure on all educational institutions and teaching-learning environments to raise individuals to meet these demands, and architecture schools are not exceptions. In this respect, an Erasmus+ project named "ArchiSTEAM: Greening the Skills of Architecture Students via STEAM Education" is conducted with researchers from Middle East Technical University (METU), University of Bologna (UNIBO), and Aalborg University (AAU). The project addresses the current demands, and the 21st-century survival skills are scrutinized. STEAM (Science, Technology, Engineering, Arts and Maths) approach is chosen to prepare architecture students by furnishing them with skills required to endure continuously changing technologies, accumulating knowledge and dynamism of 21st-century. The STEAM approach, which does not aim to deliver the components in an isolated manner but aims to provide any content by achieving the harmony between these components. ArchiSTEAM Project also delivers STEAM-based teaching modules to foster these skills regardless of the course or subject to be delivered; but considering the instructional objectives, type of content, teaching/learning activities, and the role of evaluation. As an attempt on the conduction of the proposed teaching and learning practice, a series of workshops are organized in Ankara, Bologna, and Aalborg aiming to evaluate the proposed modules in different contexts and in a short period of time. Both the project and the workshops aim to deliver and validate STEAM modules which can be conceptualized as self-contained "units" of content that with other such segments constitutes an educational course or training program [1]. In this paper, the workshop conducted in METU (Ankara) is presented with respect to the targeted outcomes of the project.

It is known that educational institutions have struggles in changing the curricula/teaching system in coping with the requirements of the rapidly evolving industry. Thus, workshops gained more importance in different levels which are a part of curricular or extracurricular activities to re-furnish existing skills or gain new skills. Although, upskilling survival skills are beyond the objective of any workshop, limited and relatively short duration of the experience not only provides an adequate medium for experimentation of novel teaching/learning strategies and to support curricular activities but also leads the future adaptations of the curricula.

The presented three-day workshop aims to illustrate how these survival skills can be conveyed and embedded into the architecture education. The workshop is designed to be inclusive for all architecture students regardless of their level of education or background knowledge/skills. For this purpose, the workshop is conducted with students from 16 different universities at different levels of education (2nd, 3rd and 4th year). Within the scope of this paper, the conduction strategies of the workshop are covered in detail to highlight the importance of these survival skills and share best practices for future works.

2. DESIGN OF THE WORKSHOP AND THE EXPERIENTIAL LEARNING ENVIRONMENT

The skills targeted for the workshop are designed to include a number of STEAM Skills (33 skills from three skill-sets: Information and Communications Technology, Ground Skills,and Problem-Based Learning Skills) that are defined in the project [1] to epitomize the STEAM modules in a short duration implementation. The workshop is constructed to reflect the phases of design, from the reformulation of the problem to design and fabrication. Hence, it is aimed to inspect the feasibility of the experiential learning scenario to form a basis for future implementations in longer durations, e.g. training, courses or complete curricula. Therefore, the objectives of each working and presentation session selected accordingly. The aimed skills and the related sessions are shown in Table 1. The session names are as follows: (1) What is Cocoon, (2) What is cocoon in architecture?, (3) Ready-Set-Go, (4) Showtime, (5) Design your own digital ecosystem, (6) Pack Yourself, (7) Hibernation Time, (8) Weave your cocoon, (9) Wrap up, and (10) Final Presentation and Exhibition. It is seen that the

covered skills are adequate to reveal the potential of the experiential learning scenario.

3. PROGRAM AND STRATEGIES

The workshop is designed based on strategies that are defined to provoke the creativity by liberating the students from the constructs of their own discipline in a collaborative environment while working in a limited time. Therefore, timing and objectives are controlled via a tight program prepared and distributed at the beginning of the workshop (Figure 1).

In this program, the balance between social

Table 1
The aimed skills and correspondent sessions for Cocoon Workshop

Skill Identifier	Skills	1	2	3	4	5	6	7	8	9	10
ICT-A1	Being able to conduct in depth research in relation with the problem	●	●	●				●			
ICT-A2	Being able to collect relevant information	●	●	●				●			
ICT-A3	Being able to use different search tools and medium	●	●	●				●			
ICT-A4	Being able to conduct smart search by using a number of combination of keywords	●	●	●				●			
ICT-B1	Being able to acknowledge the limitations and potentials of software and choose appropriate tools for given task			●	●			●	●	●	●
ICT-B2	Being able to produce data in different media			●	●			●	●	●	●
ICT-B3	Being able to transfer data to different media			●	●			●	●	●	●
ICT-C1	Being able to cope with digital collaboration tools	●	●	●				●		●	
ICT-C2	Being able to utilize cloud based technologies	●	●	●				●		●	
ICT-E1	Being able to troubleshoot software and hardware problems									●	
G-C1	understand the application of the mathematical and physical principles underlying the architecture and engineering sector							●	●	●	
G-C2	Being able to utilize tools for the management of technical information									●	
G-C3	Being able to work independently and in a team	●	●	●				●		●	
G-C5	Being able to identify, formulate and solve complex problems that require an interdisciplinary approach			●		●	●	●			
G-C6	Being able to communicate the results of your work graphically, through presentations and technical reports				●		●		●		●
PBL-A1	Being able to identify and define search terms	●	●	●				●		●	
PBL-A2	Being able to select the proper sources for the search	●	●	●				●		●	
PBL-A3	Being able to summarize and conclude the search	●	●	●				●		●	
PBL-A4	Being able to understand the purpose of taking notes	●	●	●				●		●	
PBL-A5	Being able to use note-taking techniques	●	●	●				●		●	

Table 2
The aimed skills and correspondent sessions for Cocoon Workshop (cont'd)

Skill Identifier	Skills	1	2	3	4	5	6	7	8	9	10
PBL-A6	Being able to sort and use notes for writing	●	●	●				●		●	
PBL-B1	Being able to establish a common understanding of a certain task	●	●	●		●	●	●		●	
PBL-B2	Being able to organise work between multiple individuals in order to solve a certain task	●	●	●			●	●			
PBL-B3	Being able to optimise own and others work by sharing individual work to a common result	●	●	●			●	●			
PBL-B4	Being able to understand the dualism between a problem and solution space			●				●		●	
PBL-B5	Being able to identify a problem					●	●			●	
PBL-B6	Being able to clearly formulate the problem					●	●				
PBL-B8	Being able to define criteria for a viable solution			●				●			
PBL-B10	Be able to evaluate concepts and solutions that solves specific problems							●			
PBL-B11	Be able to decide upon what solution to choose based on systematic evaluation							●			
PBL-B13	Being able to identify project goals and project limitations					●	●				
PBL-B14	Being able to manage the scope, timing and quality of a project					●	●				
PBL-B16	Being able to understand the open-ended and iterative nature of a problem-based project					●	●				
PBL-C1	Being able to use basic drawing tools							●	●		
PBL-C2	Being able to use basic drawing techniques							●	●		
PBL-C5	Being able to apply drawing/modeling skills in the process of sketching							●	●		
PBL-C6	Being able to evaluate sketches as a basis for new sketches						●				●
PBL-C7	Being able to iterate the problem formulation in order to narrow the solution space			●				●			
PBL-C8	Being able to define criteria for a viable solution			●				●			
PBL-C9	Being able to develop proposals that corresponds with the criteria for solving the problem			●				●			

activities, lectures, and hands-on working periods and presentations is determined carefully. And the schema showing the notation of the program (Figure2) is shared with the students at the beginning of the workshop.

The program is followed strictly to ensure the objectives to be met. Also, as it can be seen in the program, the workshop is organized to be taken place in many spaces in the Campus such as Digital Design Studio (DDS) and Computer Laboratory (CL) in Fac-

Figure 1
Program of the
Cocoon Workshop

	Day 1 // 25.09.18	Day 2 // 26.09.18	Day 3 // 27.09.18
08:30 - 08:45	Registration Welcome ! [DDS]	Get Together [DDS -> Design Factory]	Get Together [DDS -> Design Factory]
08:45 - 09:00			
09:00 - 09:15		ReCap - How to survive in Digital Medium [Design Factory]	
09:15 - 09:30		Survival Kit [Design Factory]	
09:30 - 09:45	Introduction to Workshop: Hello World [DDS]	Design your own digital ecosystem [Design Factory]	Weave your Cocoon [Design Factory]
09:45 - 10:00			
10:00 - 10:15	Speed Networking [DDS]	Pack yourself [Design Factory]	
10:15 - 10:30			
10:30 - 10:45	Coffee Break [DDS]	Drink coffee think better [Design Factory]	
10:45 - 11: 00			
11:00 - 11:15	Group Formations and Mentor Assignments [DDS]		
11:15 - 11:30			
11:30 - 11:45	Knock Knock: Biology and Architecture [CompLab]	Hibernation Time [Design Factory]	
11:45 - 12:00	Mining the Data: Hello Prof. Google [CompLab]		
12:00 - 12:15	What is Cocoon? [CompLab]		Transfer [Design Factory -> DDS]
12:15 - 12:30			
12:30 - 13:30	Lunch Break [DDS]	Lunch Break [Design Factory]	Lunch Break [DDS]
13:30 - 13:45	Domain-Range- Mindmapping- Process [CompLab]		
13:45 - 14:00	What is Your Cocoon in Architecture? [CompLab]		
14:00 - 14:15			
14:15 - 14:30	Ready - Set - Go [DDS]	Hibernation Time [Design Factory]	The Final Showtime & The Curtain [DDS]
14:30 - 14:45			
14:45 - 15:00			
15:00 - 15:15			
15:15 - 15:30			
15:30 - 15:45		Coffee Break [Design Factory]	
15:45 - 16:00			
16:00 - 16:15	Coffee Break [DDS]	Weave your Cocoon [Design Factory]	
16:15 - 16:30			
16:30 - 16:45	Showtime 1 & Reflections [Kubbealti]	Transfer [Design Factory -> DDS]	
16:45 - 17:00			

ulty of Architecture and Design Factory (DF). While DDS and CL provide a suitable environment for research and design, DF provides an environment eligible for hands-on learning and fabrication giving the possibility to learning while doing.

Figure 2
Event types executed throughout the workshops

In this workshop, the students are expected to work in groups to foster a collaborative working environment which can also be described as a survival skill. The learning/teaching strategies adopted while designing the workshop are (1) pushing students out of their comfort zone by providing an ill-defined problem and directing participants to conduct an multidisciplinary research, (2) scheduling by giving well defined tasks in a limited time and promoting punctuality, (3) scaffolding as an teaching activity, and (4) use of computational design as an enabler of survival skills.

3.1 Leaving the Comfort Zone

In order to promote creativity and enable students to gain new skills, pushing students out of their comfort zones plays a crucial role. For this purpose, three approaches are followed namely; i) providing an ill-defined problem, ii) forcing students to conduct research in multiple disciplines and iii) expecting students to merge and relate their findings in a meaningful whole serving the design objective.

Initially, the theme of the workshop needed to be an ill-defined problem forcing students to make research in different disciplines from various sources; hence, letting students open their minds to new perspectives in order to enhance imagination and creativity. Thus, "Cocoon" is given as the theme with brief information as "A cocoon is not only a protective shell but also is a morphogenesis space helping you to move from one state to another." Students are asked to design their own cocoon for their next state of themselves. A great concern is dedicated to the choice of the subject and to encourage students to leave their comfort zone. With a challenging topic as cocoon, it is aimed to stimulate designer's curiosity and creativity at one side and by forcing them to leave their comfort zone, it become possible to create a motivation to explore the subject in different fields.

Adapting principles from a biological phenomenon to architecture is proposed as an exercise to bring information from different disciplines together enabling students to experience information from other fields than architecture. The students are also encouraged not to limit themselves with Biology and Architecture and explore how other disciplines/fields use the Cocoon concept. By suggesting an exploration on the perspectives of other disciplines, this exercise has great potential for students to think out-of-box and broaden their understanding of space. In that sense, it is aimed to show students that the information retrieved from different disciplines are related with each other consisting the parts of a whole by showing the role of the architecture in this context.

3.2 Scheduling

Scheduling plays an important role in the design of the workshop as the duration of the event is limited and compressing the design and fabrication process in a three-day workshop is a challenging task. In contrast to "breaking the comfort zone" strategy, a set of very well defined tasks is provided to the students with respective expected outcomes of each task. The punctuality is persisted throughout the workshop.

It is aimed to conserve the iterative nature of design while supporting students with short lectures. The phases of the workshop can be summarized as research, reformulation of the problem, design, and fabrication. At each phase, the constraints of the problem are refined and changed with respect to the expected outcome forcing students to adapt themselves and their design proposals to the new situation.

3.3 Scaffolding

Scaffolding is a type of teaching activity in which coaches/mentors provide support to students needs. Scaffolding breaks the one size fits all understanding and enables the promotion of diversity in terms of knowledge/skills and levels of students. As the workshop is not limited with respect to the educational background or level of education, scaffolding is used as the primary teaching activity to enable students to gain expected skills and foster their knowledge with respect to their level. Each group is assigned a mentor which monitors and assures the progress of both the group and the individuals.

3.4 Computational Design

"Cocoon Workshop" is constructed as a computational design workshop. The computational design is embraced in design education for a while (Çolakoğlu, Yazar, 2007) (Oxman, 2008) however, with the rapid technological development, not only teaching the tools but also creating awareness on new technologies and enabling students to understand the logic behind these tools becomes essential. This idea brings us the concept of computational design which can be understood with modeling and production as an enabling medium to realize the strategies mentioned above.

Computational design by its nature is open to inclusion of different approaches which are mostly defined by the problem assigned or concerned by the participants. In this regard, it can be considered as a powerful mean to foster multidisciplinary studies and related skills expected in the course of time. It is possible to claim that computational design problems are not only ill-defined problems like other design problems but also, they are problems forcing designers more to create their own design ecosystems including appropriate soft and hard technologies. Thus an experience-based environment offers great potentials to substantiate the role of interdisciplinarity and lifelong learning in design education and to further develop new pedagogic approaches to reinforce the related design skills.

4. IMPLEMENTATIONS: PROJECTS AND RESULTS

The workshop is documented with many photos, time-lapse footage and outcomes of the projects by means of posters and physical models. In addition to this report, the images and an informative video are shared via the project website [2] and announced to the public via social media pages of the project and the official web page of the department of architecture.

4.1. Daily Tasks and Final Outcomes

As shown in the previous section, the workshop is designed to include various types of activities i.e. lectures, hands-on working periods, presentation and social activities. As a result of these activities, students are expected to achieve 3 Milestones and present them to the tutors and other students. Initially, the groups are asked to make a quick presentation which is limited with 5 minutes on the gathered research findings of what cocoon is from various fields on a single slide. This session is not only designed to achieve a milestone but also aiming to help students to gather and document the findings

in a coherent way to proceed with information transfer into the architectural domain which is the second milestone of the workshop. At this phase, students are asked to relate and map the information that they obtained from different disciplines into the architectural domain. Findings and initial ideas of the groups are presented in 4-5 slides in 5 minutes by the students at the end of the first day (Figure 3). After the second presentation session, the groups started to work on their design solutions to achieve the final outcome of the workshop which is presented with a physical model and two posters representing the scenario, design process, fabrication, and the outcome. These processes are presented in the Figure 4.

5. DISCUSSIONS AND CONCLUSION

The workshop is evaluated by means of conducting pre-post surveys including multiple-choice and open-ended questions to measure participants' self-evaluation of survival skills and perception of STEAM and architecture relevance. In addition, the observations of mentors and reflections acquired in the colloquium held at the end of the workshop with the mentors, participants, and observers are used to analyze the success of the workshop and the STEAM approach in education.

The findings did not show any significant correlation between participants' performance, and age, gender, the institution or city of residency. In contrast, the level of education plays an important role in self-evaluation of the participants which can be explained with self-confidence. This confidence can be related with having more experience in similar projects and/or learning activities. On the other hand, pre and post-surveys revealed that, as the students approach the end of their undergraduate studies, this self-confidence blinds the self-evaluation. While second and third-year students reported low scores on their knowledge and abilities in regard to the STEAM skills, fourth-year students reported a

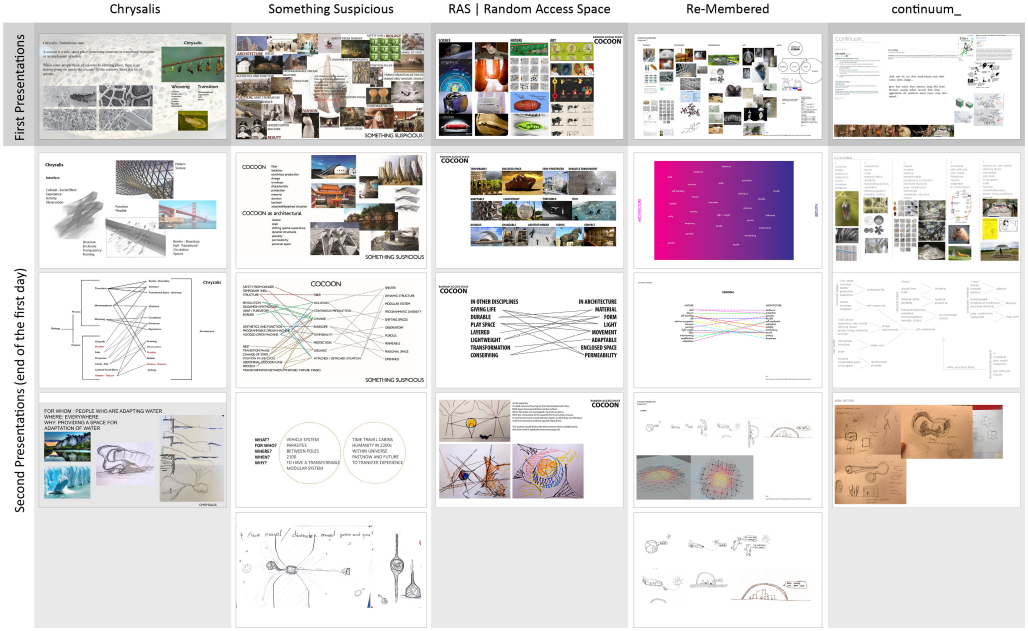
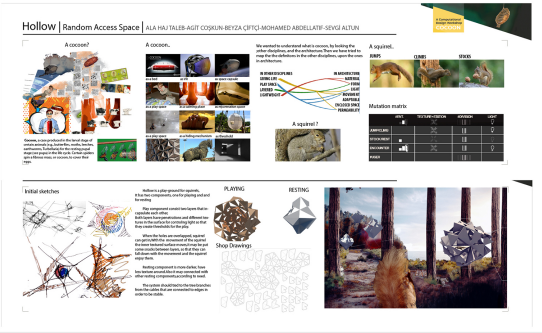
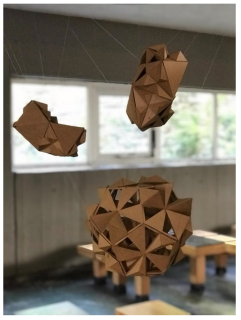
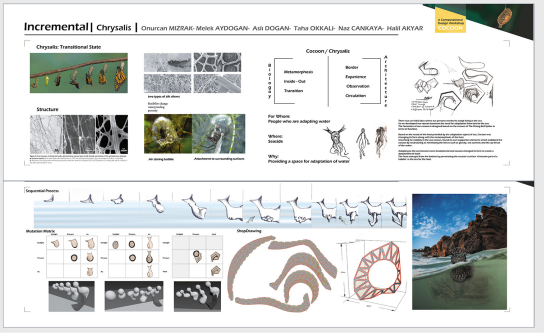


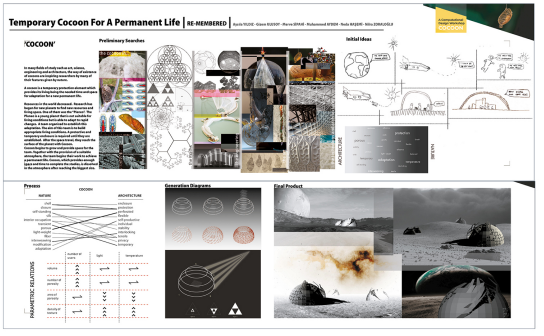
Figure 3
The outcomes of first and second presentation sessions

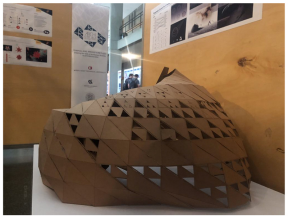
Figure 4
Some of the final outcomes of the workshop











high score in the pre-test. Correspondingly, a significant increase is observed second-year students whereas the fourth-year students reported slightly lower scores than pre-test responses. The results proclaim that pushing students out of their comfort zone also plays a crucial role in the self-evaluation and increase self-motivation to make up their lacking knowledge and skills. In this sense, the STEAM approach is generic and flexible and are able to reach to students regardless of the level of students. The responses to the open-ended questions regarding the reflection of the participants and the colloquium indicated that the workshop was a successful experience both for the participants and mentors in the realm of the project. The very first remark related to the workshop is the role of the subject or problem assigned. It is all accepted that curiosity and excitement motivate learning and thus, all the participants were so eager to explore what "cocoon is" and it was observed that subject matter was a key for triggering their creativity.

Secondly, it was observed that the role of the schedule was very crucial both for mentors and participants in fulfilling the required learning objectives and providing related outcomes. It was seen that students never lost their interest and their enthusiasm in these three days since each phase was new and challenging for them. The followed schedule and all the intermediate steps were means for them to have self-awareness of their progress. In every progressive step, it was observed that participants became more confident and more engaged in the learning process.

Finally, the role of mentors in the groups was very crucial and it was seen that they can effectively work in groups and be productive as long as mentors facilitate the design process by supporting them with proper assessments and coaching techniques with respect to the individual needs of the students and/or groups.

To sum up, the Cocoon Workshop is evaluated as a successful workshop not only in terms of the variety of the design results but also in terms of conveying the intended skills to the learners by means of the teaching/learning strategies forming the core of STEAM approach in architecture. In this respect, the workshop facilitated for the purpose of validating the outcomes of the ArchiSTEAM project along with other workshop organized by the University of Bologna and Aalborg University and course implementations in three universities.

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