ODTÜ METU

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA A.D. 1088

AD NYE VEJE AALBORG UNIVERSITET

ARCHI STEAM

Erasmus+ KA-2 Project ARCHISTEAM
"Greening the Skills of Architecture Students via STEAM Education".

Project Report

IMPLEMENTATION REPORT:
WORKSHOPS

TÜRKİYE CUMHURİYETİ AVRUPA BİRLİĞİ BAKANLIĞI
REPUBLIC OF TURKEY MINISTRY FOR EU AFFAIRS

TÜRKİYE ULUSAL AJANSI
TURKISH NATIONAL AGENCY

Erasmus+

This Project is granted by the European Commission under the Erasmus+ Programme (Lifelong Learning or Youth Programme), implemented by The Turkish Republic Ministry of European Union and the Center for European Union Education and Youth Programmes (Turkish National Agency/http://www.ua.gov.tr)

PROJECT INFORMATION

Project acronym:	ARCHISTEAM
Project title:	Greening the Skills of Architecture Students via STEAM Education
Project number:	2016-1-TR01-KA203-034962
Project website:	http://www.archisteam.com
Report name:	IMPLEMENTATION REPORT: WORKSHOPS
Date of preparation:	October 2018
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1. INTRODUCTION

Today, the prevalence of interactive technologies have yielded to the emergence of new learning environments in which learners possess their own responsibility and control of constructing new meaning for knowledge through their own experience. There is a common belief among educators that not only knowledge but skill sets as discussed in this project in properly designed Experiential Learning environments ameliorates teaching and learning process. It is also evident that in the new era, ICT skills, critical thinking skills and communication-collaboration skills are the survival skills and key factors for economic growth and social wealth. Therefore, all educational institutions and teaching learning environments around the world have been witnessing dramatic changes to meet the demands of the knowledge society.

Architecture schools are not exceptions. Thus, the ArchiSTEAM project aims to define and embed necessary skills enabling learners to work in collaborative and interdisciplinary ways into architecture curricula. The proposed structure of the curriculum helps architecture students to have the necessary knowledge and skills to become proactive members of the knowledge economy and be able to cope with future challenges and sustain their professions.

In this regard, as it is explored in the ArchiSTEAM project, skill sets that should be conveyed to students are as important as the knowledge that they should gain through their education. This process has been exemplified by three different workshops conducted by the project partners.

1.1. General Overview of the Workshops

Within the scope of this project, participating institutions Middle East Technical University, University of Bologna and Aalborg University designed and implemented 3 workshops separately based on their teaching and learning culture to have participating students to become aware of those crucial skills and practice those skills in a project-based learning environment. Even though each institution designed a workshop with different content and learning activities, the following principals were the guiding principles for all the workshops. These workshops are conducted in different dates with approximately 25-30 local students from different universities. The dates of the workshops are given in Table 1.

1. Workshops are designed in accordance with Constructivist Theory of Learning

Constructivism is a learning theory which explains how people acquire knowledge and learn. Dewey (as cited in Bhattacharjee, 2015) argued that human thought is practical problem solving, which proceeds by testing rival hypotheses (p.68). These problem-solving experiences occur in a social context, such as a classroom or in a studio where students join together in manipulating materials and observing outcomes. (Dewey, as cited in Bhattacharjee, 2015) Since it is relying on student-centered approach, students are encouraged to use active techniques (experiments, real-world problem solving) to construct more knowledge. By designing and performing a number of teaching practices for well-planned learning environment,

Table 1: Dates and locations of the conducted workshops

Site Specific Workshop	Aalborg University	September, 3
Cocoon Workshop	Middle East Technical University	September 25-27
ARCHISTEAM Workshop	University of Bologna	October 4-5

the students learn how acquire knowledge and learn.

2. Workshops used Problem Based & Project Based Learning Approaches to engage students actively into learning environment to have meaningful learning experiences.

Problem Based teaching method provides complex real-world problems as a tool to promote student learning of concepts and principles as well as provides the development of scientific and independent thinking skills, problem-solving abilities, and communication skills of students. The principles of scientific method are used in this teaching method and it can reinforce students for working in groups, finding and evaluating research materials, and provide students' life-long learning. Also, in PBL, 'students are motivated by using complex, real world problems to define and research' learning issues and to collectively communicate and combine information (Duch et al., 2001, p6).

Similarly, Project-based learning is a systematic teaching method that provide students with opportunities to construct knowledge and skills with complex, authentic questions and carefully designed products and tasks in real life based (Markham, Larmer, & Ravitz, 2003). PBL has five definitive features which includes 1) a central project; 2) a constructivist focus on important knowledge and skills; 3) a driving activity in the form of a complex question, problem, or challenge; 4) a learner-driven investigation guided by the teacher; and 5) a real-world project that is authentic to the learner (Thomas, 2000). Project-based learning is a model which differentiates from traditional teaching since the learners and their projects are focused. Learners have the opportunity to "construct own learning that is personally meaningful" and to "work more autonomously".

3. STEAM experience is essential for all students

STEAM is an educational approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking (Catterall, 2017).

True STEAM experiences involve two or more standards from Science, Technology, Engineering, Math and the Arts to be taught and evaluated through each other. On the other hand, students' understanding of how things work can be increased and their use of technologies can be developed by a true STEM education (Bybee, 2010). STEAM approach centralizes on inquiry, collaboration, and an emphasis on process-based learning.

4. Assessment is based on repeated observations, classroom discussions, formative feedbacks and peer assessment

To monitor and develop the progress of students in PBL process, formative feedbacks that moves learners forward can be given. Moreover, writing reflections by students can be used to check for student understanding at the end of a lesson. In a peer assessment, students can discuss their works and assess each other by marking, advising and correcting. (Bhaskar, 2013)

In all workshops, the following assessment principles are used:

- Simplify the process and enable the love of learning.
- Teach the students how to work collaboratively.
- Assign roles for group members.
- Provide opportunity to students for choosing their primary roles, but consider responsibility and interactivity for all group roles.
- Advise them that each individual has responsibility for every part of the process and each student's total involvement is needed.
- Supply guidance and resources.
- Evaluate the process with team and project rubrics.

In this project, Constructivism is used as the baseline learning theory and experiential learning, problem-based learning and project-based learning models are based on the principles of this theory. In all workshops STEAM is used as a form of educational practice based on the common principles of those models. The STEAM approach was essential in all workshops to provide 21st century skills by integrating both experiential learning, problem-based learning and project-based learning, using the basic principles of constructivist learning theory. The common goal of all workshops was to provide opportunities to students for "an interdisciplinary study with high-level skills and based on real-life problems" and "an active role in creating a mental model by combining the existing knowledge in the learning process with new experiences".

2. COCOON: A COMPUTATIONAL DESIGN WORKSHOP @METU, Ankara, Turkey

2.1. Introduction

"Cocoon Workshop" conducted in METU is constructed as a computational design workshop. Computational design by its nature necessitates a multi-disciplinary approach and inclusion of various subjects which are mostly defined by the problem assigned or concerned by the participants. It should be emphasized that one of the major differences of the computational design compared with more conventional design approaches is the explicit involvement of various disciplines (STEAM fields) from the very early phases of the design process. In this regard, computational design can be considered as a powerful mean to foster STEAM approach 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 to create their own design eco-systems including appropriate soft and hard technologies and as its underlined a broad range of disciplines. Thus as a PBL environment they offer great potentials to substantiate the role of STEAM in design education and to further develop new pedagogic approaches to reinforce the related design skills as grouped into three within this project.

Hence Cocoon workshop is designed in such a way that METU team's previous experience in computational design research and teaching as well as observations in ARCH 470 and ARCH 475 courses were taken as the guidelines. As explained in the previous parts, ARCH 470 and ARCH 475 are computational design studios where not only computational thinking but also computational technologies are subject matters.

Cocoon workshop is considered as a model of these afro-mentioned computational design studios implemented in a three-day time interval. A great concern is dedicated to the choice of the subject which should stimulate designer's curiosity and creativity at one side and to force them to leave their comfort zone motivating them to explore the subject in different fields ie. to encourage them to use STEAM. Following the choice of the design problem, another great effort is spent to design "the process" which actually means to design an elaborate schedule with well-defined outcome at each and every step together with related objectives, and expected teaching supports and means as explained in the section below.

2.1.1. THEME: COCOON

The project is assigned to the students with following poster including brief information about the concept, the application process, and contact information of both the workshop and the project (Figure 1). The only information provided about the theme was the text included in the poster:

> *A cocoon is your personal space which enables your rejuvenation for you to be ready to face with your surrounding world. A cocoon is not only a protective shell but also is a morphogenesis space helping you to move from one state to another.*
> *You are expected to design your cocoon for your next state of yourself.*

Figure 1: Poster of the Cocoon Workshop

The project is selected to be ill-defined in purpose in order to enhance the imagination of students as well as broadening the research area. Adapting principles from a biological phenomena to architecture is proposed as an exercise to bring information from different disciplines together as this project aims to achieve with STEAM approach. Therefore, Cocoon which is the given theme is selected because there different approaches existing in Biology and Architecture as a space of living, change, adaptation, mutation and metamorphosis. Therefore, this exercise has a great potential for students to think out-of-boundary and broaden their understanding of space with various perspectives of other disciplines.

2.1.2. WORKSHOP TEAM

Project team is consisted of people from different disciples, having different backgrounds, and expertise. There are instructors having background of engineering, architecture, education and physics working in the Faculty of Architecture and Education. The lectures and critiques given by the members is aimed to enrich the the perspectives of the students to any given problem. The team members of the workshop are as presented in Figure 2.

2.1.3. PROGRAM

The program is organized with short exercises, crash lectures and quick presentations which is controlled with a given program that can be seen in the appendices. The program is consisted of 6 group of events which are:

"Get together" *defining the time period for each day to meet and getting ready to work or transportation,*

"Time to work" *denoting the time period to complete a specific task given to the students.*

"Let's listen"*indicating the time for a crush course or discussions about the reflections of the tutors.*

"Show time" *informing students that there will be a quick presentation about their findings/designs/ideas.*

"Break" *defining the break times for coffee, lunch and coffee-talks.*

"Exhibition" *the final event of the workshop where students can exhibit their work with posters and models.*

As it can be seen in the program (Appendix1), workshop is organized to be taken place in many spaces in the Campus such as Digital Design Studio (DDS) and Computer Laboratory(CL) in Faculty of Architecture and Design Factory (DF). While, DDS and CL provide suitable environment for research and design, DF provides an environment eligible for hands-on learning giving possibility to learning while doing.

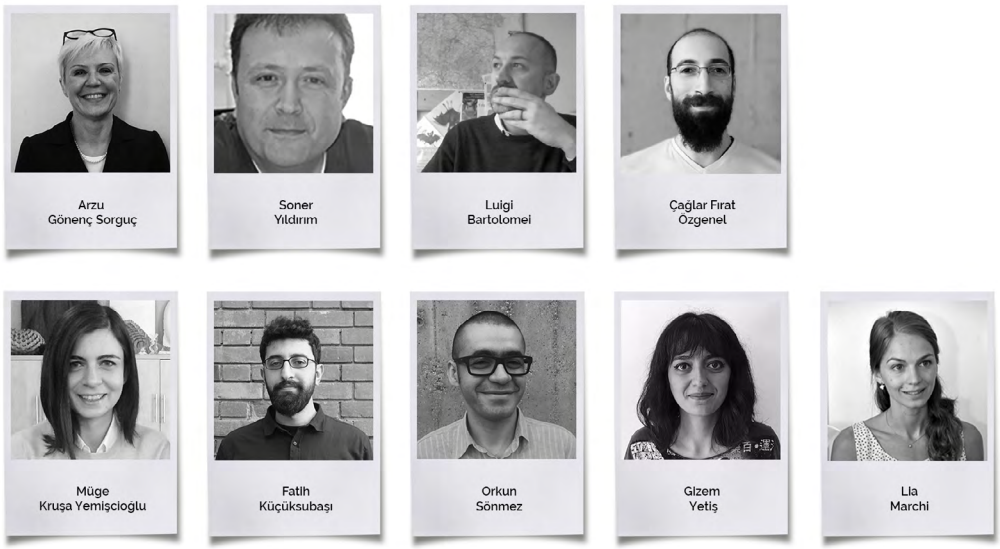


Figure 2: Cocoon workshop team

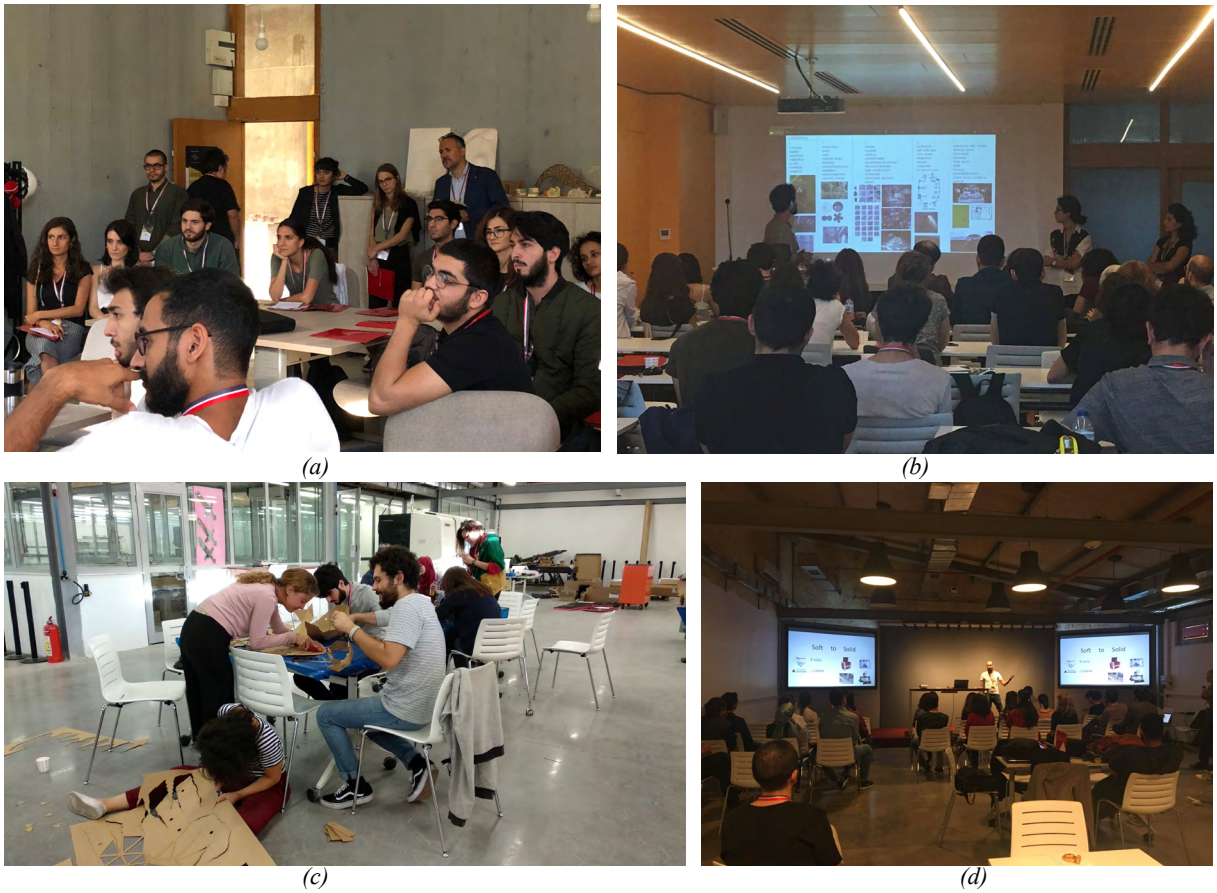


Figure 3: Locations where the workshop is conducted [METU Department of Architecture: (a) Digital Design Studio, (b) Computer Lab; METU Design Factory (c) Production Area, (d) Stage]

Students are asked to bring their own laptops and work on any software they feel to be comfortable. The infrastructure provided for them was spaces for study, lecture and exhibition in Faculty of Architecture and working place, stage, laser cutter and workshop for fabrication and assembly in Design Factory.

2.1.4. ANNOUNCEMENT

The announcement of the workshop is made publicly through websites of the project [archisteam.com], METU Faculty of Architecture [arch.metu.edu.tr], Department of Architecture[archweb.metu.edu.tr], and many digital platform about architectural design which are followed by students namely "arkitera.com.tr" and "mimarizm.com". These public announcements can be seen in the attachment. Also, many researchers from different universities in Turkey are reached via an email to inform their students about the workshop. Depending on the students emails and questions, it is seen that as some of the students are attended the workshop because their instructors are informed them, some of them had seen the the public announcement and previous works of the team and decided to join.

In these announcements and posters, the applicants are informed about the application process which is an online form published in the website asking brief personal information, CV and their expectations from the workshop. These data are used for selecting eligible applicants.

2.2. Conditions for the selection and preparation of a Experiential Learning Environment

2.2.1. PARTICIPANTS

2.2.1.1. APPLICATIONS

The workshop is announced via social media such as facebook and twitter accounts, official webpage and news websites (arkitera.com, mimarizm.com, yapi.com.tr (appendix 1)). Furthermore, prepared posters are printed and displayed in Middle East Technical University. As a result, 60 individual applications are received from 18 universities from Turkey and Northern Cyprus. For applications, levels of the students are not asked but being an undergraduate architecture student is indicated as an eligibility criteria. 18 male and 42 female students applied for the workshop.

Table 2: The distribution of accepted applicants

	Application	Eligible	Selected	Attended
Abdullah Gül University	1	1	1	0
Anadolu Üniversitesi	1	0	0	0
Atılım University	1	1	1	1
Başkent University	2	2	2	2
Bilgi University	1	0	0	0
Bilkent University	4	2	2	2
Eastern Mediterranean University	1	0	0	0
Eskisehir Osmangazi University	1	1	1	0
Gazi University	2	1	1	1
İstanbul Gelişim University	1	0	0	0
İstanbul Technical University	2	2	2	0
İzmir University of Economics	1	1	1	1
Kadir Has University	1	1	1	1
Middle East Technical University	18	17	10	10
Middle East Technical University (Waiting List)			6	3
Mimar Sinan Fine Arts University	1	1	1	1
TED University	6	5	2	1
Tobb University of Economics and Technology	14	11	4	4
Uludağ University	1	1	1	1
Yaşar University	1	0	0	0
total	**60**	**47**	**30**	**28**

2.2.1.2. ELIGIBILITY CRITERIA

Among 60 applications, 47 of these applications were eligible. 13 of the applications are rejected due to not fulfilling the application criteria (application from graduates and missing information). Among 47 applicants, 30 attendees from 14 universities are selected primarily to ensure variety of universities and level of education and secondarily on first come first serve basis.

2.2.1.3. PROFILE OF THE ATTENDEES

7 of the applicants are also accepted for the waiting list. The gender distribution of the selected applicants is almost equal with 12 male 18 female students in primary list and 3 male and 3 female students in waiting list. The distribution of accepted applicants is presented in Table 2.

Prior to the workshop 5 of the accepted students in the primary list and 3 student in the waiting list reported that they will not be able attend to the workshop. Most of the cancellations are believed to be relate with residing at a different city and having accomodation problems. As a result, the workshop is conducted with 28 undergraduate architecture students from 12 different universities and 4 cities. The majority of the students were female with 19 students while 9 male students participated in the workshop.

2.2.2. SET CRITERIA FOR THE EXPERIENTIAL LEARNING SCENARIO

The skills targeted for the workshop is designed to include as much as STEAM Skills which are defined in O3 report, yet achievable in a three day workshop. The workshop is constructed to reflect each phase of designing, from 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 implementations in longer durations, e.g. modules, courses or full curricula. The objectives of each working and presentation session selected accordingly. The aimed skills and the sessions related with them are shown in the Table 3. 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.

The STEAM skills which are not included within the scope of the workshop are discluded due to being limited in time. Yet, covered skills are considered to reveal the potential of the experiential learning scenario.

Table 3: 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	●	●	●				●		●	
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					●	●				

Skill Identifier	Skills	1	2	3	4	5	6	7	8	9	10
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			●				●			

2.2.3. PREPARATION PHASE

2.2.3.1. ASSESSMENT CRITERIA/RUBRICS FOR THE ASSESSMENT OF THE EXPERIENTIAL LEARNING ENVIRONMENT

In order to assess the effectiveness of the Experiential Learning Environment prepared for the workshop, particular skills proposed in the O3 Report are identified. These are particular types of skills which are most interrelated among three main groups of skills issued; ground skills, PBL skills, and ICT skills. They are also most expected to be employed in scope of this workshop; in addition to that they are not domain-dependent.

Students' self-reflections on these skills and how these self-reflections change after their experience of design process in the experiential learning environment are considered as main assessment criteria. Observers' evaluations of how students use these skills during the workshop are also required to investigate any coherence with the change in student's self-reflections.

2.2.3.2. PRE-POST SURVEY

A pre-workshop survey is prepared for the participant students with the aim of collecting data regarding their self-reflection towards the STEAM Skills defined within the project. Undoubtedly, the number of STEAM Skills are considerably high for requesting self reflection from students. For this reason, the STEAM Skills are firstly selected with respect to the context and content of the workshop in terms of observability and then they are grouped under 16 skill items. These skills are asked with graphic rating scale with three items as Degree, Neither agree or disagree, Agree. These questions cover a wide range of skills varying from research skills to note taking, being a team member, problem solving. Apart from the 16 skill questions, the relevancy of architecture and maths, design, arts, engineering and science are also asked with graphic rating scale with three items [Appendices].

The very same questions are also asked as a post-workshop survey. By this way, it is aimed to observe any enhancements in the self-reflections of the participants, whether the workshop facilitated as an instrument of self confrontation, whether the participant were able to determine their strong and weak skills.

Furthermore, a third survey is distributed to the participants which asks for their own reflections and recommendations for the workshop with the aim of determining whether there is a discrepancy between the workshop objectives and participant expectations and possible suggestions for learning environments, activities or any component of the workshop.

All three surveys are shared with the participants via Google Forms and they are asked to fill the forms before and after the workshop but strictly not during the workshop.

While the pre and post survey containing 16 skill questions are asked together with the name of the participant, the open ended question about the workshop reflections are collected anonymously. In this sense, the first two surveys enabled researchers to trace the changes before-after the workshop and correlate with the student classes while the participants feel free to express their opinions without restraining themselves.

2.2.3.3. CONDUCTION APPROACH

Grouping

Considering workshop has an intense program needed to be fulfilled in three days and planned to be concluded with a fabrication process, grouping the students become a must. Groups are planned to be formed by the students, but to ensure the variety of the group members and skill sets, some ground rules are designed for group formations such as:

- Groups will be formed with either 5 or 6 members.
- As there are 14 students accepted to the workshop from METU,there can only be 2 METU students at most and one from other universities for each group.
- While they are forming their groups students

are advised to pick members with different backgrounds, skills, universities, levels, and genders.

- The initial task is designed to decide on a group name. Therefore, it is aimed to enhance the sense of belonging to a group for the students.

Mentoring Assessment and Rubrics - measurement, evaluation

To support the design process efficiently and monitor the process and progress one coach is assigned to each group from the young mentors of the projects. As coaches are proceeding with the same group of students, they are also asked to note the STEAM related skills throughout the process for each working time period. The tables are prepared based on the skill sets proposed in the project (O3) and their assessment rubrics. One of the example sheets can be seen in the Figure 4. These sheets are prepared not only to assess the students and processes, but also to be a guide for the coaches to achieve the objectives of the education module, and monitor and lead the process. This approach is embraced to eliminate any bias originating from the mentorship and provides a fair learning environment for each student.

Actions for provoking creativity

Initially, by requesting information from different disciplines, sources and approaches, it is aimed to liberate the students from the constructs of their own disciplines and let them open their minds to new approaches, and perspectives. As they quit their comfort zone which is the way of research and design that they have been taught in architectural education, it is aimed to make them see the relations among different disciplines as well as architecture.

Workshop is designed by following similar steps already implemented and experienced in Digital Design Studio courses in a long term. As it is stated in the program, workshop is consisted of phases of research, redefinition of the problem, design and modeling, and fabrication. As students are liberated from predefined constraints of their discipline by encouraging them to adapt information from other disciplines, implementation of these information to the redefinition phase and designing accordingly broaden their perspective and thus their creativity. By modeling with modeling softwares and scripting, it is aimed for them to understand and construct the relations among different information of both reference domain and architecture. In this process using various medium to model, present, post-process and fabricate is not only contribute to their ICT skills, but also their creativity while searching for a relation between the medium and their design.

Skill Identifier	Skills	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6
ICT-A1	Being able to conduct in depth research in relation with the problem	Fully Observed	Fully Observed	Partially Observe	Partially Observe	Partially Observe	Fully Observed
ICT-A2	Being able to collect relevant information	Fully Observed	Fully Observed	Fully Observed	Fully Observed	Fully Observed	Fully Observed
ICT-A3	Being able to use different search tools and medium	Observed	Observed	Observed	Observed	Observed	Observed
ICT-A4	Being able to conduct smart search by using a number of combination of keywords	Partially Observe	Partially Observe	Partially Observe	Partially Observe	Partially Observe	Partially Observe
ICT-C1	Being able to cope with digital collaboration tools	Fully Observed	Fully Observed	Fully Observed	Partially Observe	Partially Observe	Fully Observed
ICTC-2	Being able to utilize cloud based technologies	Fully Observed	Fully Observed	Fully Observed	Fully Observed	Fully Observed	Fully Observed
G-C3	Being able to work independently and in a team	Fully Observed	Fully Observed	Partially Observe	Partially Observe	Partially Observe	Fully Observed
PBL-A1	Being able to identify and define search terms	Partially Observe	Partially Observe	Partially Observe	Partially Observe	Partially Observe	Partially Observe
PBL-A2	Being able to select the proper sources for the search	Fully Observed	Fully Observed	Fully Observed	Partially Observe	Partially Observe	Fully Observed
PBL-A3	Being able to summarize and conclude the search	Partially Observe	Partially Observe	Partially Observe	Partially Observe	Partially Observe	Partially Observe
PBL-A4	Being able to understand the purpose of taking notes	Fully Observed	NA	NA	NA	NA	NA
PBL-A5	Being able to use note-taking techniques	Observed	NA	NA	NA	NA	NA
PBL-A6	Being able to sort and use notes for writing	Observed	NA	NA	NA	NA	NA
PBL-B1	Being able to establish a common understanding of a certain task	Partially Observe	Partially Observe	Fully Observed	Fully Observed	Fully Observed	Fully Observed
PBL-B2	Being able to organise work between multiple individuals in order to solve a certain task	Fully Observed	Fully Observed	Partially Observe	Partially Observe	Partially Observe	Fully Observed
PBL-B3	Being able to optimise own and others work by sharing individual work to a common result	Fully Observed	Fully Observed	Partially Observe	Partially Observe	Partially Observe	Fully Observed

Figure 4: Example assessment sheet for the coaches to follow the process according to the skillsets proposed by the project.

2.3. Experiential Learning Environments Design-Implementation-Assessment Processes

2.3.1. OUTCOMES AND ASSESSMENT CRITERIA

The outcomes of theMETU workshop is determined with respect to the duration and constituents of the workshop process. It is aimed to conduct an interdisciplinary research on a wicked problem and conclude with pjysical fabrication. The participants are also expected to work in groups of five or six people.

The criteria for physical outcomes of the METU workshop are listed as below:

- You must design for a user of your own choice.
- Your design must reflect the requirements of the user that you defined.
- Your design must reflect the information you gathered and synthesized from other disciplines

In addition, several constraints are given to the participants for the physical submissions as follow:

1. Each group must submit two 90x30 cm posters on given template (Figure 5) including:

- Project name, group names, name of the participants
- Research outcomes
- Redefinition of cocoon
- Definition of the user (persona)
- A diagram showing how the information acquired from other disciplines relate to their cocoon definition in architecture
- A matrix showing how design changes with respect to changing forces, parameters and features
- Examples of shop drawings showing the fabrication strategies
- Illustrations for their initial ideas and its development
- Renderings of the design instances

2. A physical prototype conforming the requirements of:

- Fitting in a 50x50x50 cm box or volume of 125000cm3.
- Fabricated with 1mm cardboard (craft paper and black)
- Fabricated using laser cutter

Apart from the physical outcomes, following learning outcomes are defined as:

- Be able to conduct individual research using ICT tools on a given subject
- Be able to relate to other disciplines
- Be able to share, communicate and merge the research findings with other
- Be able to conduct group work
- Be able to create a use case scenario
- Be able to come up with a design solution to a wicked problem
- Be able to utilize digital collaboration tools
- Be able to follow and contribute to computational design process
- Be able to understand the requirements of digital fabrication and produce shop drawings for fabrication
- Be able to present design output and design process graphically and verbally

While the conformity of the submissions are controlled throughout the workshop by the mentors, these submissions are also utilized as an instrument to assess the learning outcomes of the workshop.

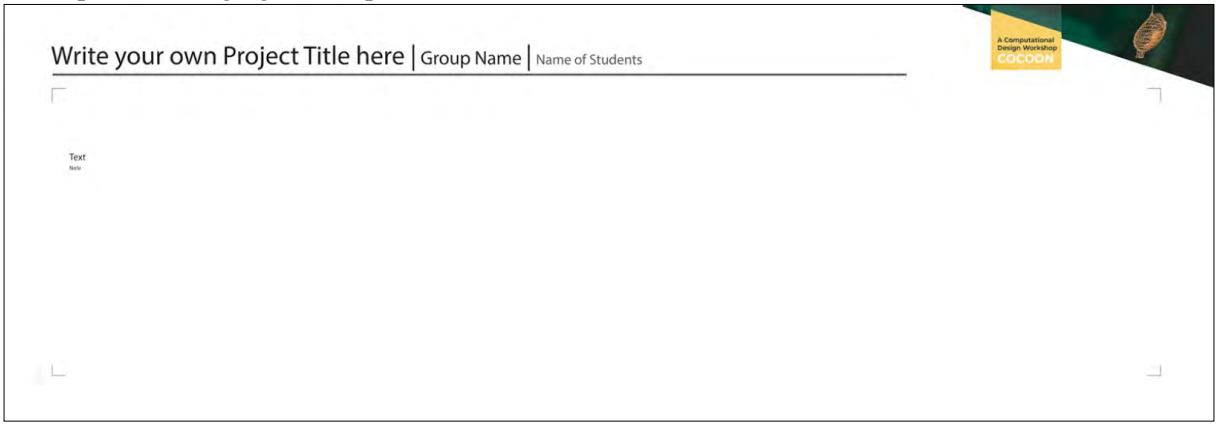


Figure 5: Poster Template given to the students

2.3.2. EXPERIENTIAL LEARNING SCENARIO

Experiential learning scenario is characterized by providing a wicked problem of Cocoon. The them is purposely selected for not being a direct connotation in architecture. Hence, the participants are motivated to conduct a research on the theme not only in architecture but also in other disciplines, especially in biology.

Correspondingly, the participants are also motivated to define their own users, design scenarios, and provide a physical outcome. In that sense, the METU workshop is defined to encapsulate tasks of conducting research, reformulation of the problem, designing and fabricating the designed product.Even though these may seem to have an sequential order, each of these tasks require revisiting the previous ones (e.g. for reformulation of the problem, a second research phase is required). Hence, the workshop process is a cyclic one conforming with the Kolb's Theory of experiential learning and is constructed to be iterative instead of linear.

2.3.3. INTRODUCTION OF EXPERIENTIAL LEARNING SCENARIO TO STUDENTS – NEGOTIATE WITH STUDENTS ON OUTCOMES AND THE PROCESS

The experiential learning scenario is introduced to the students right after the groups are formed together with the interim phases of the workshop and students are scaffolded by explaining the purpose, the use, potentials and limitations of the interim tasks. For each task, the outcomes and expectations are also introduced.

2.3.4. RESEARCH PHASE OF THE SOLUTION – LET THE STUDENT ANALYZE AND SYNTHESIZE POSSIBLE SOLUTIONS

For the research phase of the METU workshop, half of the first day is dedicated. As the very first task of the workshop is to define the problem, a comprehensive research is needed in order to formulate their own problem and users. The participants are guided to focus on extreme conditions and cases to foster imagination and creativity and to liberate participants from their perception of conventional architecture.

The first submissions of the participants are expected to reflect initial findings of their research in other disciplines and how these research findings corresponds to architecture. In this context, first two tasks are named as "What is your Cocoon?" and "What is your Cocoon in Architecture?".

2.3.5. PRODUCTION – STUDENTS EVALUATE POSSIBLE SOLUTIONS AND COME WITH THE BEST SOLUTION

Due to the iterative nature of the workshop, participant are expected to produce various solutions for each task and select the best option with respect to the requirements. Yet, this selection is not definitive; instead participants are encouraged to revisit their "best" solutions when they encounter a problem in the following tasks and iterate their ideas for new requirements. In this context, the workshop serves as an optimization action for acquiring the best solution from the research phase to fabrication in a cyclic manner. Although, the number of tasks for the short duration of the workshop is very demanding, the participants are expected to share the workload within their groups resulting in the increase of the importance of communication and group collaboration.

2.3.6. ASSESSMENT – PROVIDE FEEDBACK TO STUDENTS ABOUT THE PROCESS AND THE PRODUCT

Two formal presentations, one at the end of the first day and one as the final presentation, are expected from the participants to reflect their progress and feedback to their works are given by instructors, mentors and other participants. Apart from the formal presentations, mentors were working in rotation to provide feedback to each group and to ensure all groups are on the track. As a result, each participant and group received feedbacks for each task. After the final presentation, a general reflection session is planned for providing feedback to students, instructors and workshop organizers.

2.4. Implementation

The workshop is documented with many photos, time lapse footages and outcomes of the projects by means of posters and physical models. In addition to this report, the images and informative video are shared via the project website: http://archisteam.com/cocoon/ and announced to public via social media pages of the project and the official web page of the department of architecture; archweb.metu.edu.tr.

2.4.1. DAY1

The first day of the workshop is started with a registration of the students that is completed by 09:30. At that period, program of a workshop is given to the students and for those who are coming from outside of METU, some basic information is given about the faculty building and services. Then, welcome speech which is titled as "Hello World" is given by Prof. Dr. Arzu Gönenç Sorguç by introducing the workshop, program and the team members to the students. Later on mentors leads to the students to the outside of the faculty for Speed Networking activity which is decided to be conducted for students to meet with their possible team members considering that they are all coming from different universities and they have not met with each other. The session led by Fatih Küçüksubaşı succeeded to provide students a common ground to know each other decide on their team members, thus they form their groups (5-6 members) afterwards and coaches are assigned to groups randomly. To enhance their feeling of belongingness, they are asked to choose a group name and they are called with that name from then.

After the first phase of the workshop which is introduction and grouping, the crowd is moved to Computer Lab for the lectures. Lectures about nature-driven studies in architecture title "Knock Knock: Biology and Architecture" is given by Müge Kruşa Yemişcioğlu and Prof. Dr. Arzu Gönenç Sorguç aiming to guide students to an interdisciplinary research field: biomimetics. As basic information is given to students about the meaning, methods, some important examples of the field are also shared and discussed with students. Then, students are asked to make a research about

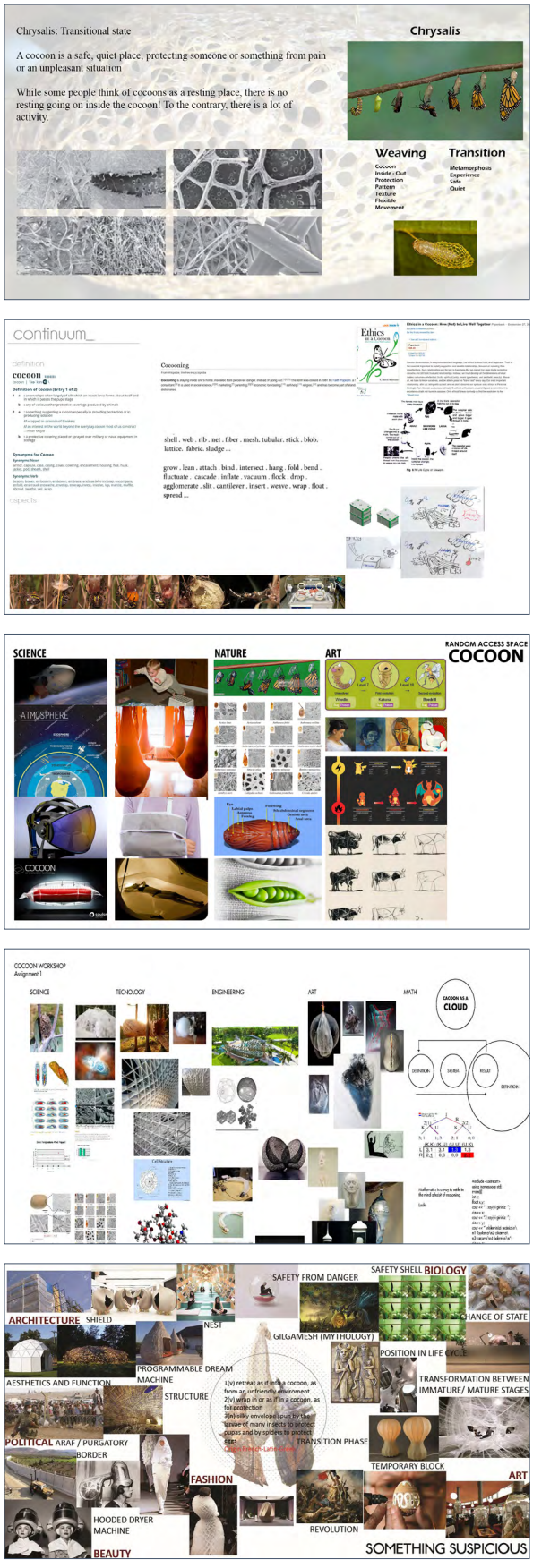
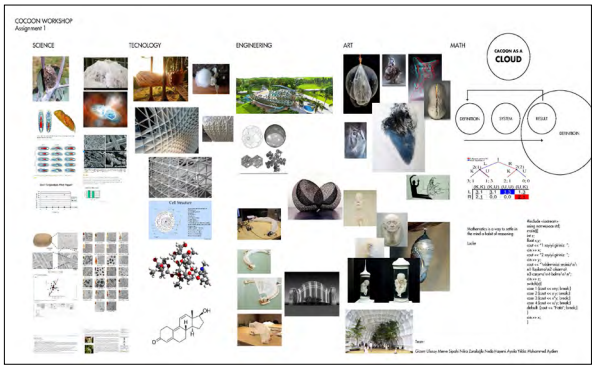
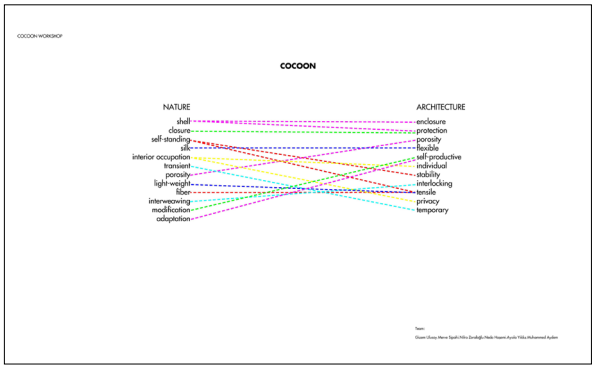
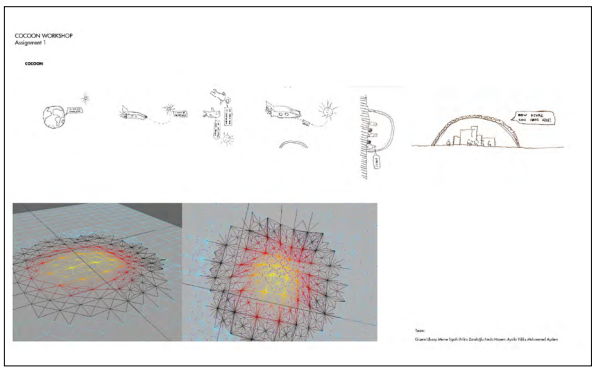


Figure 6: First posters of the groups reflecting their initial findings.







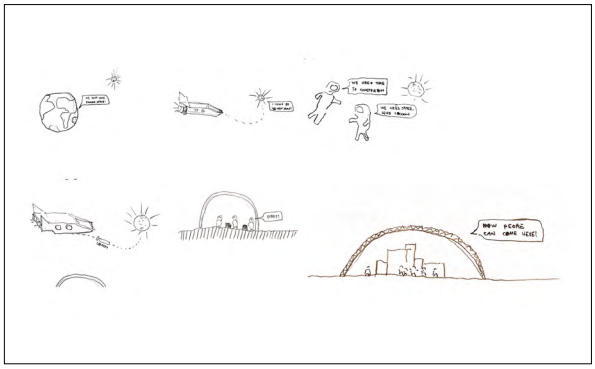


Figure 7: End-of-day presentations of re-membred group

Figure 8: Student Presentations

what cocoon is from various fields and gather these informations on a poster (1920*1080px) and presented them in a quick presentation sessions which are limited with 5 minutes. The first posters can be seen in Figure 6.

After the lunch break, the idea of information transfer and its strategies are introduced with the lecture titled "Domain-Range-Mind Mapping-Process" given by Prof. Dr. Arzu Gönenç Sorguç. In this lecture, constructing a relation among domains and understanding the meaning of this transformation is explained verbally, with diagrams and examplifary projects. With the help of the this information, students are asked to prepare a 4-5 slides showing their research finding, how they reflect these information into architecture and their initial design ideas. These slides were presented by the group members in 5 minutes and mentors gave feedbacks about all slides and suggestions about the future of the project. Posters of the one of the groups are presented in Figure 7, and the others are included in the appendices.

2.4.2. DAY 2

The second day of the workshop is initialized in METU Design Factory with the lectures titled "How to survive in Digital Medium" and "Survival Kit" given by Dr. Çağlar Fırat Özgenel. In these lectures, students are informed about fabrication methodologies, strategies and tactics. Raising an awareness about data transfer among different softwares and from modeling software to fabrication is aimed in these lectures with examplifary production stories and models. Furthermore, the potentials, limitations of laser cutting method are covered together with various approaches for assembling the fabricated parts, common pitfalls, tips and tricks.

After the lectures, until lunch break students are asked to finalize their design process and preparing for the fabrication phase of the workshop. The coffee break of this intense working session is designed as a "Drink coffee think better" session which includes a lecture talk given by Prof.Dr. Soner Yıldırım introducing the student architecture the concepts of learning and cognition enabling them to understand the process they are going through and developing an awareness on their learning strategies. After lunch break, students are directed to finalize their models and to provide the shop drawings for the fabrication. As some groups was able to finalize the drawings, some of them needed to work more on the morning of the next day.

The second day of the workshop was consisted of intense working sessions following the steps of the projects strictly with the guidance of the coaches and mentors. Therefore, students and projects became ready for the fabrication and exhibition time.

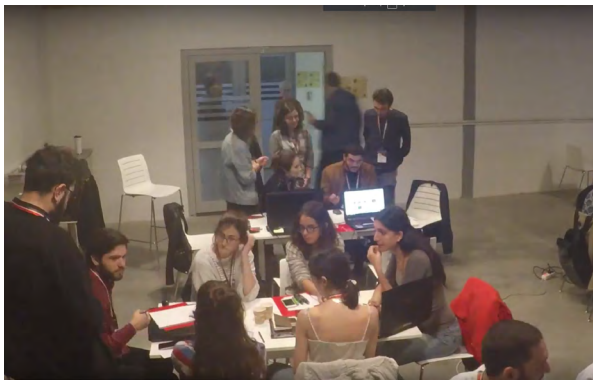


Figure 9: One of the instances of the working time at METU Design Factory.

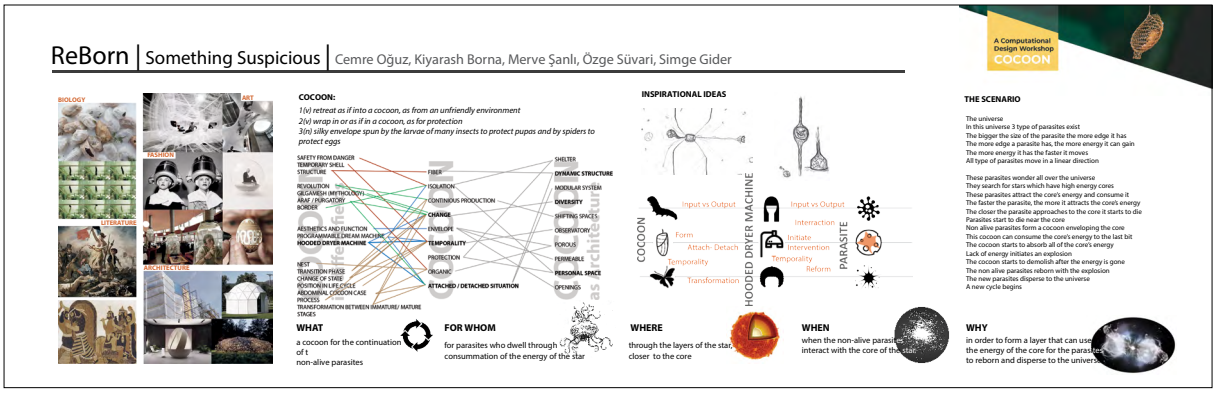
Figure 10: Students assembling the models

2.4.3. DAY 3

The last day of the workshop mainly focuses on fabrication and exhibition. It started in METU Design Factory. Students are expected to prepare shop drawings of their models prior to fabrication. They are restricted to use only limited amount of cardboard as the material and cutting-engraving as the fabrication technique in modelling. The reason behind this restriction is to demonstrate the importance of effective time and resource management as in real life scenarios.

Trotec Speedy 500 Laser Cutter and Engraver is utilized in fabrication process in order to produce the parts which is used in the models. After the requirements in shop drawings for the machine are announced to the students, they start creating files for fabrication. Then, the students assemble the parts in order to form their digital models in physical material world (Figure 10). After the models are assembled and the posters are printed, the exhibition area is arranged. The posters are placed next to respective models. Final posters of the groups can be seen in Figures 12-16.

Figure 11: Exhibition of outputs of the workshop (Photo Credit: Ali Rad Yousefnia)



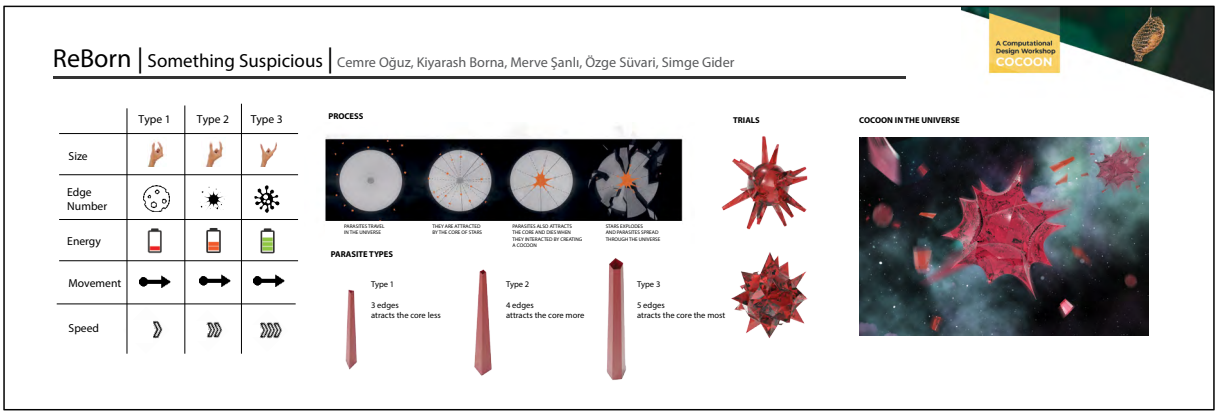


Figure 12: Final Posters of "Something Suspicious" group

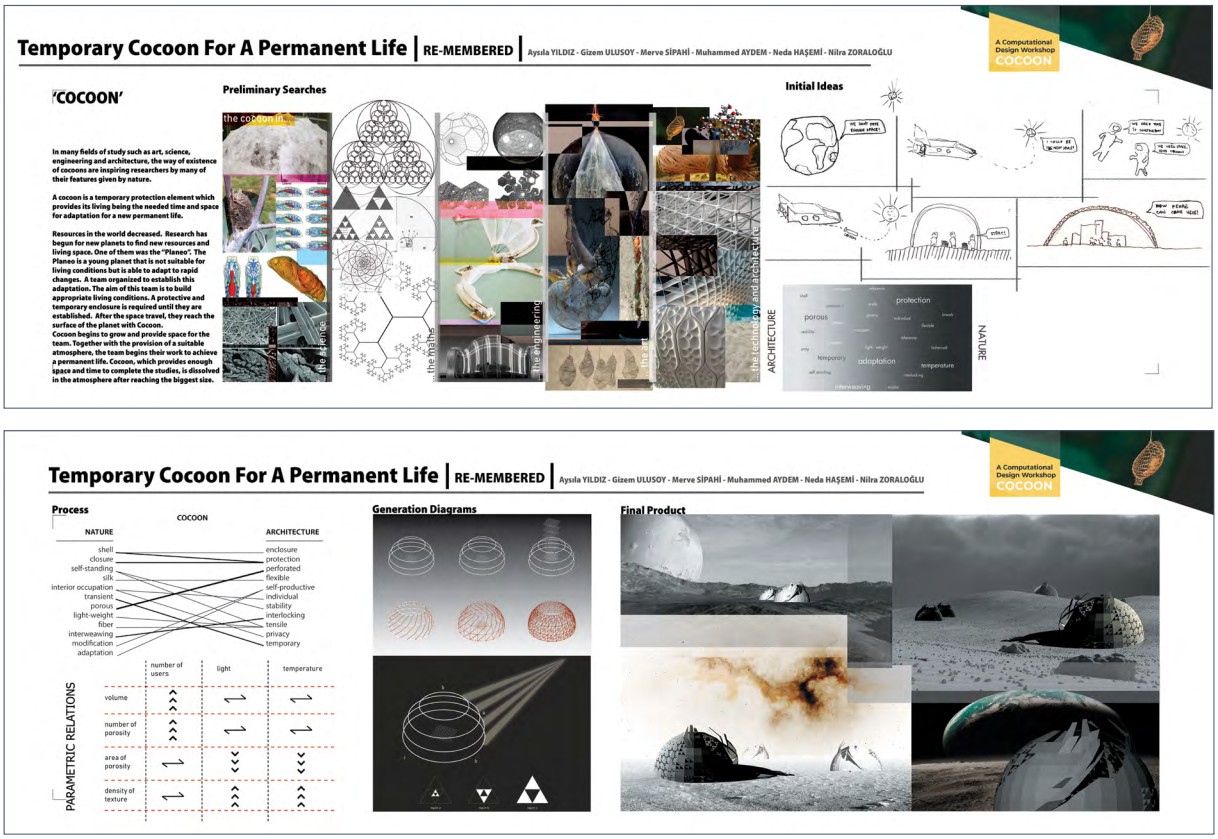


Figure 13: Final Posters of "Re-membered" group

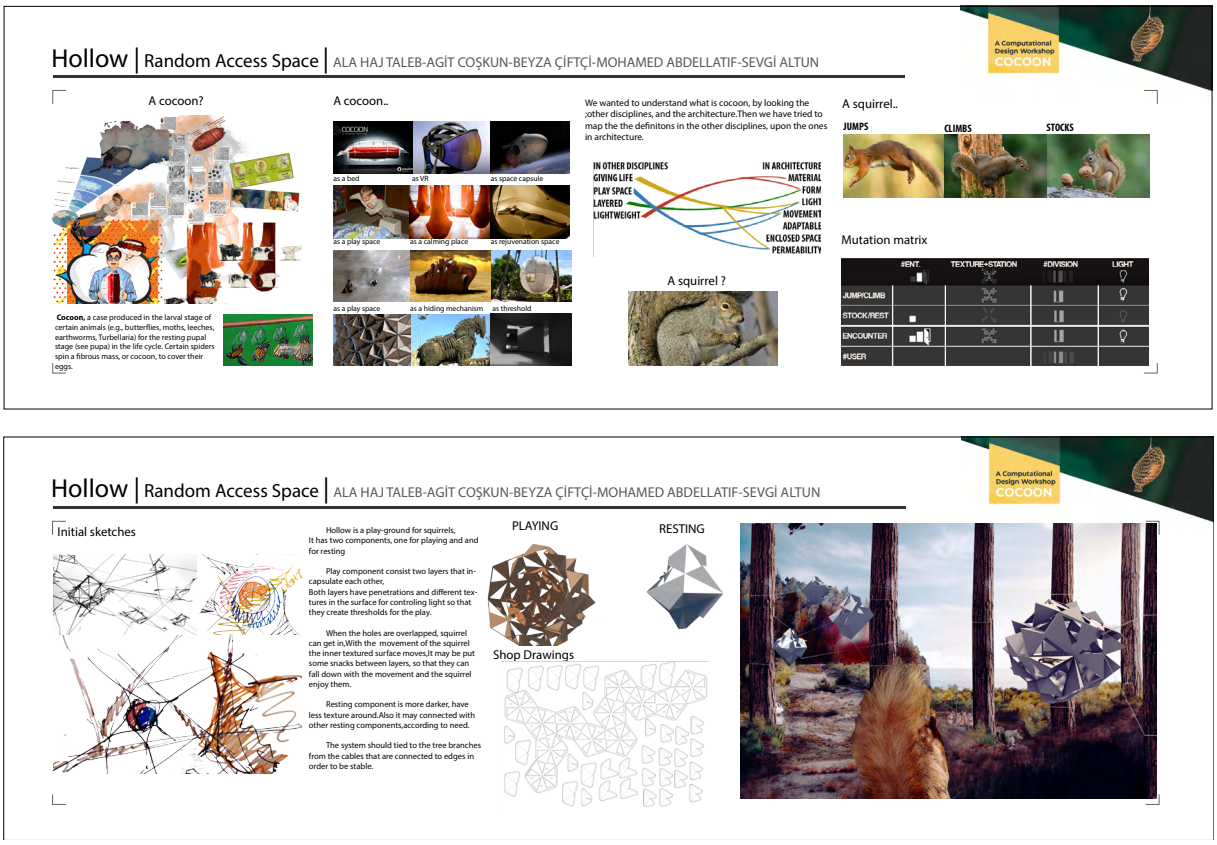
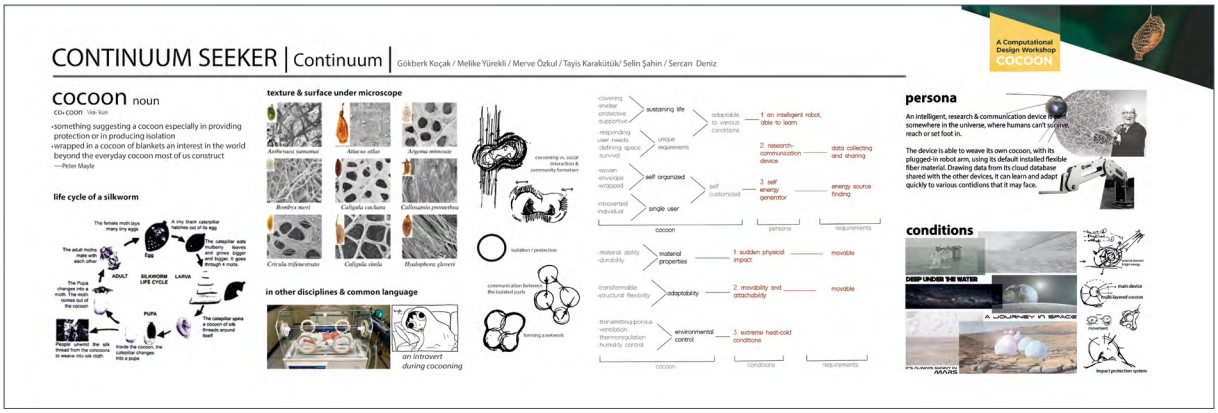


Figure 14: Final Posters of "RAS: Random Access Space" group



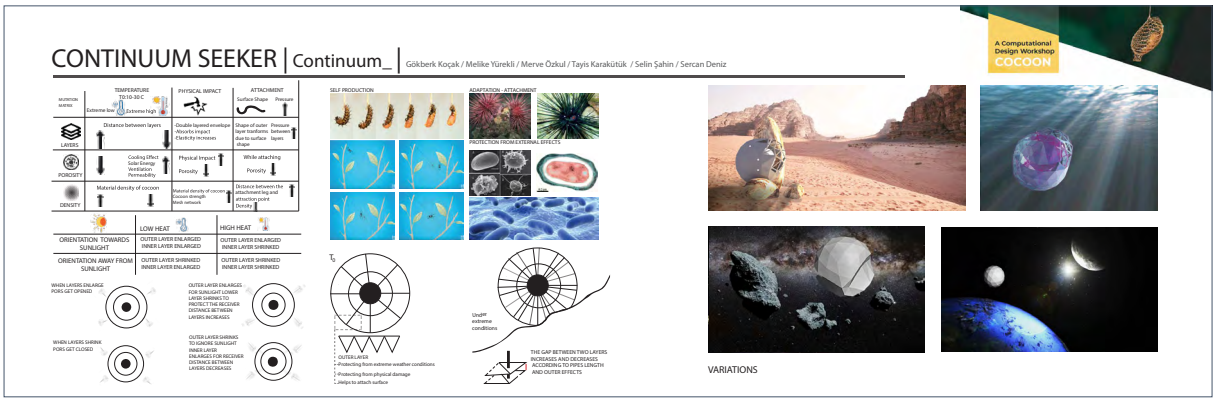
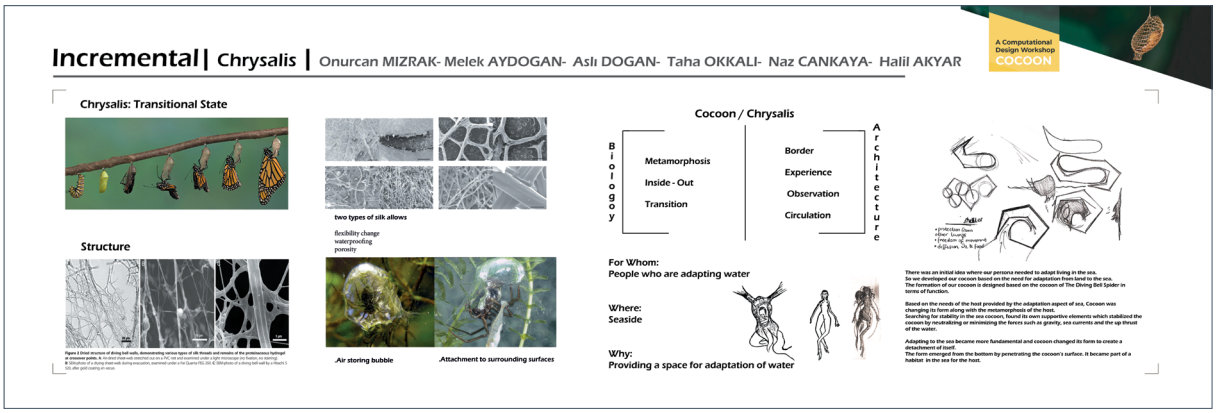


Figure 15: Final Posters of "Continuum" group



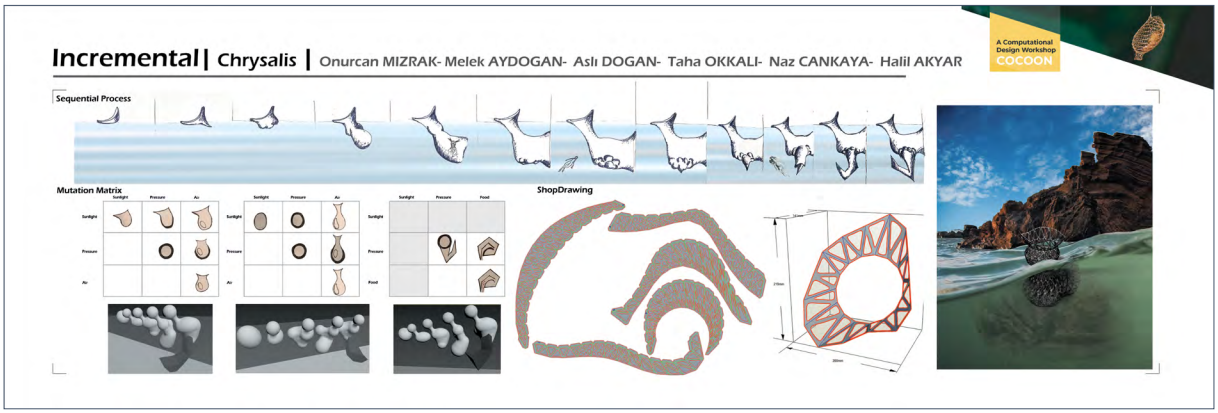


Figure 16: Final Posters of "Chrysalis" group

2.5. Results and Discussions

2.5.1. PRE-POST SURVEY AND SELF-REFLECTION RESULTS

Primary assessment method is chosen as the comparison of pre-post workshop surveys. The 16 skills chosen for the surveys can be categorized under 5 groups as: research skills, software & technology based skills, problem solving skills, process management skills, and collaborative skills. The results are inspected in a two fold manner as the variation before and after the workshop and the mean results of the survey data. In addition, the correlation between student classes and survey responses are inspected. Although, data for gender and university are present, the correlation of these dimensions are omitted due to uneven distribution of the samples.

Responses for research skills based questions revealed that no significant change is observed in 3rd year and 4th year students whereas 2nd year students showed more self-confidence after the workshop. Although the overall response of the students for habit of note taking and referring back to them is satisfactory after the workshop, a decline is observed regardless of the level of students. Similarly, responses for being able to conduct in depth research on a given problem shoen decline after the workshop. These results are evaluated as the workshop facilitated as an instrument for students to confront themselves and find themselves as needing improvement for research skills.

For software & technology based skills, the self-confidence of students for using cloud based technologies and comfort in switching between multiple software are observed to be enhanced throughout the workshop. Especially 2nd year students responded low scored prior to the workshop but increased their responses after the workshop. It is believed that low score of 2nd year students are caused by the level of expertise and not being confronted by situations forcing them to use such technologies. As the level of students increase, responses of the students show greater self-confidence in these skills. Correspondingly, forcing students to challenge their skills played an important role in enhancing the skills and self-confidence.

The problem solving skills of students are observed to be enhanced slightly. Yet, as their response for pre-workshop survey was already high, no major change is observed regardless of the level of students.

Students are observed to lack self-confidence in terms of managing the process and communicating the results of their work graphically. Especially, 2nd and 3rd year students responded with low scored prior to the workshop. Yet, after the workshop the responses increased to a satisfactory level. Similar to the increase in software & technology based skills, the responses are enhanced to a satisfactory level due to being confronted with challenges enabling their skills throughout the workshop.

There is no significant change in the collaborative skills of the students except the utilization of digital collaboration tools which can be regarded as a skill combining both collaboration and ICT skills. On the other hand, a slight decrease in the post workshop survey shows that the students recognize themselves as needing improvement in being open to collaboration.

Apart from the questions targeting the self-reflection of students for their STEAM skills, the relevance of architecture with mathematics, design, arts, engineering and science is also asked in the pre and post workshop surveys. The relevance of arts, engineering and science are observed to be increased from the perspective of the 2nd and 3rd year students while all fields except arts decreased for 4th year students. For overall evaluation, relevancy of arts and science is increased. This result is evaluated with the relation of content of the workshop. While, a biology focused theme forced students to get out from their comfort zones and to enhance their STEAM skills, it also enabled students to link science and architecture in a deeper level. It is anticipated that if the workshop theme is more focused on any of the dimensions, an increase in that dimension would be observed. As a result, all of these dimensions must be covered throughout architectural education in order to obtain full set of STEAM skills.

2.5.2. REFLECTIONS AND CONCLUSION

Cocoon workshop is a successful experience both for the participants and mentors in the realm of the STEAM project.

The very first remark related with the workshop is the role of the subject or problem assigned. It is all accepted that curiosity and excitement motivate learning. All the participants were so eager to explore what “cocoon is” and it was observed that subject matter was already triggering their creativity.

İt was seen that although backgrounds of the students (where they come from, their experience, the year etc) were different, and in the very beginning they were not confident and did not feel comfortable in the environment. But once they were asked to work in groups, it was observed that there was a general relief not only in them but in general.

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 as discussed previously

It was observed that the role of 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 learning process.

Cocoon workshop is a valuable exercise for STEAM project showing how STEAM and related skills can be conveyed to learners. The importance of subject matter i.e problem, the role of PBL environment, the role of mentor and teaching and assessment approaches have been experienced once more as it has been argued in this project.

3. ARCHISTEAM WORKSHOP @UNIBO, Cesena, Italy

3.1. Introduction

We choose to verify students' abilities away from their "comfort zones" and from a typical academical environment. Even taking place in the new building of the Faculty of Architecture in Cesena, students have been invited to abandon their typical alum attitude by means of strategies of barrier-breaking, such as changing the layout of class tables, providing coffee makers and teapots.

The goal of these light changes was to weaken the formal aspect of the environment, encouraging a frank reflection on the discipline and on the workshop's theme, so that the exchange between professors and students would not be really influenced by formal roles but rather on the physical object this community has to deal with.

Students were invited to accomplish two different tasks at the same time: on the one hand they had to propose a meaningful solution to the theme of the workshop, on the other they were asked to monitor the compositional process itself in order to recognize phases, roles, abilities and competences emerging during the elaboration of the idea.

In this way the specific argument of the workshop became a sort of tool, by means of which analyzing student's curricula, abilities, and self awareness in relation to the drawing process.

Despite all participants dedicated the most part of their time trying to reach a good definition of their architectural proposal, surveys and reflections on the drawing activity were collected time by time and especially at the beginning and at the end of this brief experience.

3.1.1. THEME

Students have been invited to propose an idea to make evident the state boundaries between Italy and san Marino Republic. San Marino is one of the smallest states in the world, both in terms of area (520 sqkm) and population (33400 inhab.). As the Vatican See, the Serenissima Republic of San Marino is a totally independent inter-state in the Italian territory.

The proximity to the Italian state implicates a long tradition of relationships and friendship, also for the sharing of the same culture, which is expressed both in the italian language, as in traditions typical of the rest of Romagna.

Nevertheless San Marino boasts a long tradition of independence and autonomy which dates back probably to the IV century, according to tradition, certainly demonstrable from 1291.

Being regulated by the constitutions of 1600, San Marino is the oldest sovereign state and constitutional republic in the world. The tradition wants that it have been founded on September 3, 301 by the stonecutter (and Saint) Marino of Rab, a monk of byzantin origins and founder of a religious community on Titano Mountain. The traditional autonomy of the Republique dates back to his oral last will, traditionally synthesized in the expression «Relinquo vos liberos ab utroque homine». Thus, freed from the control of the Pope, on the one hand and the Emperor, on the other, the State of San Marino has maintained its independence and territory in a symbiotic relationship with Italy. This is also recognizable by salient facts, such as the numerous volunteers that, from the small state, joined the Italian soldiers during the First and Second World War, despite the neutrality of the Republic.

Making San Marino land distinguishable from Italian territory is a challenge which appeared more than once even in the recent italian history: in the late Eighties Giancarlo De Carlo was invited by the republic to draw the new Gates for the Republic. The project saw only a partial realization and a new competition for the Gate in Gualdicciolo was launched in 2013, won by Studio Antao, with a parametric representation of a giant tree. Even this project has not seen the realization.

Drawing a boundary for San Marino Republic is an hard work. It should be a border to mark a diversity but not a caesura, to assert a tradition and an ancient friendship.

The particularity of the theme was chosen to abstract the students from their "comfort zones" and bring them on an original and complex topic.

This was also useful to open a critical reflection on contemporary politics, where boundaries, both in Europe as in the United States, are markers of differences and exclusions.

3.1.2. WORKSHOP TEAM: WHO WE ARE, HOW DID WE CONTRIBUTE

The workshop team was made up of the partners from the European project:

UNIBO: Ernesto Antonini, Luigi Bartolomei,

METU: Arzu Gönenç Sorguç, Soner Yildirim, Müge Kruşa Yemişcioğlu, Çağlar Fırat Özgenel, Fatih Küçüksubaşı, Orkun Sonmez

AAU: Nicolai Steinø, Nis Ovesen

We have also to thank and to mention Eng. Irene Frassoldati, former student at the Unibo faculty of Engineering, who attended the workshop as voluntary tutor after have accomplished her Master at the London School of Economics and Political Science.

Luigi Bartolomei and Irene Frassoldati acted in the role of tutors during the workshop, while other members of Partners Institutions intervened as external advisors, providing comments on student's activities at the end of the main two phases in which the workshop experience was divided.

The tutors were instead available to the students during the entire workshop, answering doubts or questions of individuals and/or of groups, never intervening in any problem that could have occurred as consequence of group dynamics. However, perhaps because students knew each other for a long time and acted in already experimented and established groups, the group work did not show problems related to communication and mutual listening.

3.1.3. PARTICIPANTS

Students attending the workshop were volunteers applicants from the fifth year in architecture curricula at the faculty of Cesena. Organizers opened the participation also to student groups already used to work together.

All participation requests have been accepted.

Actually, all students demonstrated to know each other and spontaneously aggregated into already tested working groups.

In this way the workshop was participated by 6 teams that then choose a name in relation to the concept they took as goal and inspiration for their drawing activity.

The conformation of these groups is summarized in Table 4.

The disproportion between the male and female component reflects the whole orientation of the school, whose female presence is superior to the male one.

3.1.4. ANNOUNCEMENT MEDIA OF THE WORKSHOP

The workshop was announced through institutional channels, both physical (posters in the School's venues) and virtual (department mailing list and department web page). In addition, great use of social network such as Facebook was made, in order to reach as many students as possible: also in this case, institutional Facebook pages were reached.

Table 4: The conformation of the groups in the UNIBO workshop

Group number	Group name	Total Number of Participants	Male	Female
1.	Allusive Borders	4		4
2.	Borderline	5	2	3
3.	Il cielo sopra San Marino	4		4
4.	Abitare la Linea	4	4	
5.	Pendolari	4	1	3
6.	Tower Bank	4	1	3
		25	**8**	**17**

Figure 17: A card used for the announcement of the workshop

3.2. Program

The program of the workshop was constituted by the following phases:

Students were supposed to work with their own computer.

As organizers, we provided them big format paper (A0, A1) and tracing paper for sketches and sharing ideas.

Phase	Contents	Communication
Intro : WORKSHOP INTRODUCTION Cesena October 3rd, 2018 10.30 - 11.00	Introduction of all partners. Brief illustration of Archisteam project. Illustration of the theme of the workshop and of its working phases.	One to many presentation (Unibo Team)
Phase 1.A Brainstorming phase 11.00 - 13.00	Participants are supposed to focus on the specific theme of this workshop and to talk each others about the imaginary connected to the theme itself. This phase goal is made to propose a wide examination of the concept, in order to underline the possibility of a common imaginary, or a convergence on the meanings to be expressed. At the end of this phase each group should chose a representative name in order to represent its own approach.	Group work
Phase 1.B Towards a strategy and a concept 13.00 - 15.00	Focusing on the brainstorming, students were supposed to individuate strategies to solve the specific case providing a concept, a new paradigm to see and conceive a border and the one between San Marino and Italy in particular.	Group work
Presentation I 15.00 - 15.45	All groups were invited to share their reflections by means of one panel 70x100 to collect and show ideas, imaginaries and words illustrating each group work. In this way each group was exposed to the comment of tutors, advisors and peers.	Group presentation in front all participant, tutors and external advisors.

Phase	Contents	Communication
Phase 2 Formulating a preliminary architectural project October 3rd, 15.30 - October 4th, 16.00	This phase is definitely the longest one and it is about the translation of the brainstorming results into a consequent and consistent architectural proposal.	Group work with tutors
Presentation II October 4th, 16.00 - 17.00	All groups were invite to share their final product in a 70x100 panel illustrating their preliminary architectural project waiting for tutors, advisors and peers comments.	Group presentation in front all participant, tutors and external advisors.

3.2.1. IMPLEMENTATION PHASES

Figure 18: Lectures by Prof. Antonini and Bartolomei

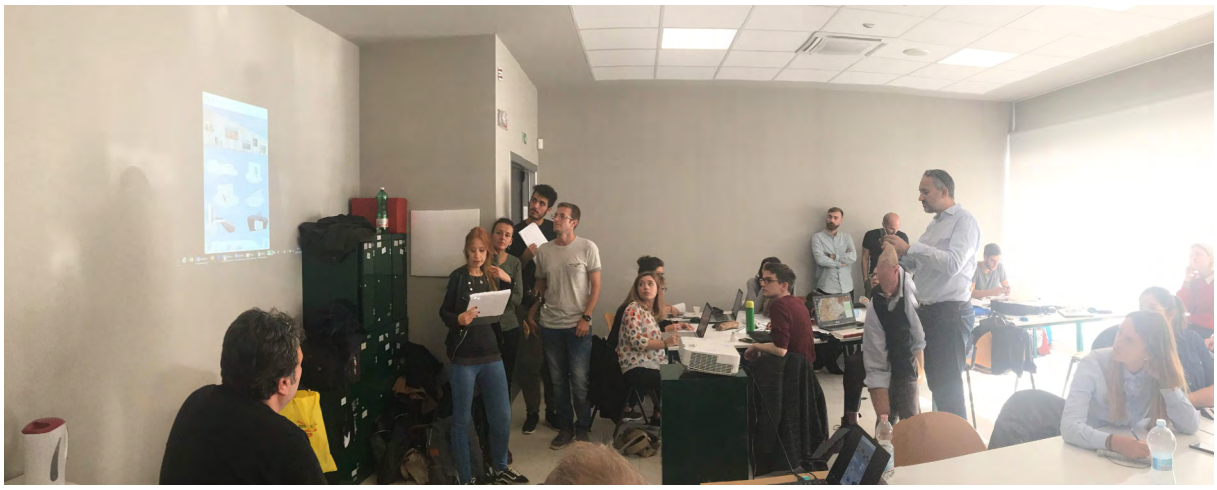


Figure 19: Mid-term review (presentation 1)

Figure 20: Students at work after the mid-term review

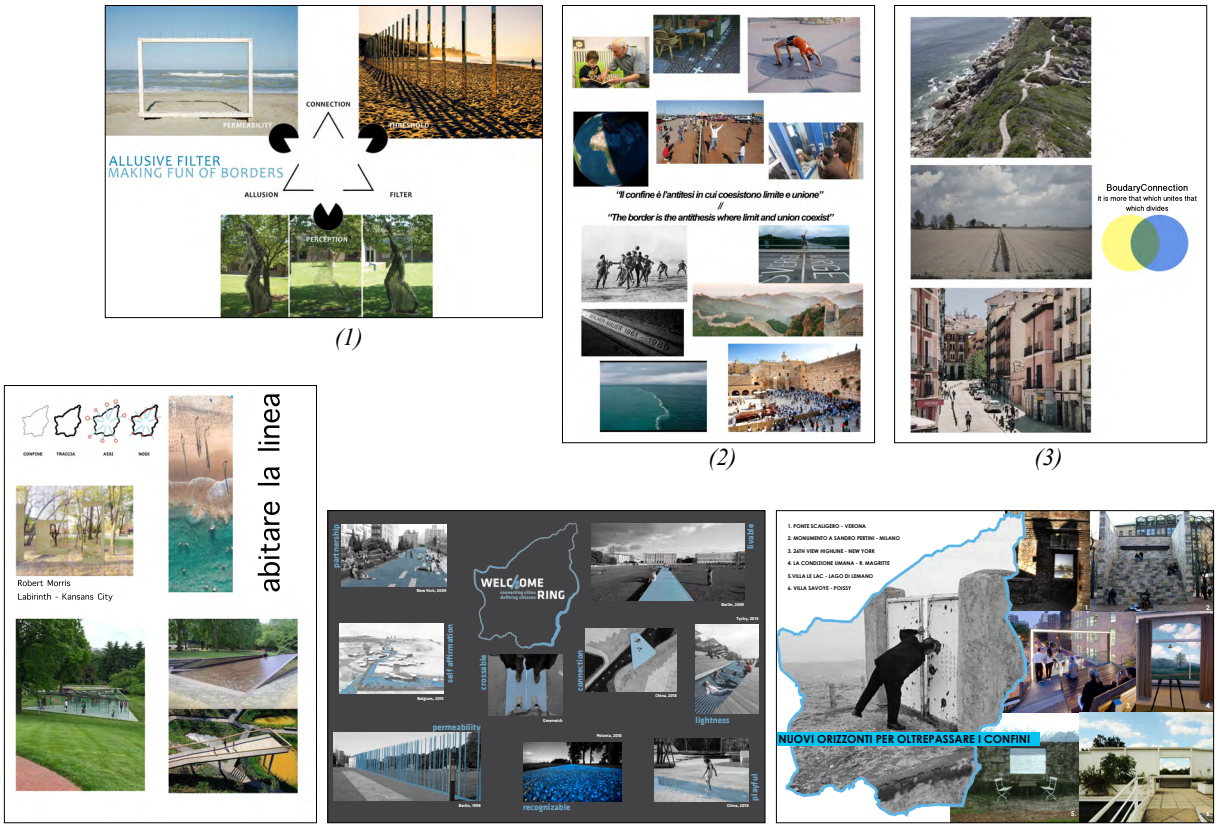
Figure 21: Final presentation of posters

3.3. Results

3.3.1. PRESENTATION (CONCEPT PHASE)

October 3rd, 15.00 - 15.40

Providing a global analysis, the imaginaries proposed proved to be characterized by an archetypal and/or phenomenological figurative approach to borders rather than by a political or institutional one as it is possible to makes evident looking in detail at the posters presented as result of Phase 1.



(1) *(2)* *(3)* *(4)* *(5)* *(6)*

Figure 22: Posters of the concept phase. In order: 1) Allusive borders; 2) Borderline; 3) Il cielo sopra San Marino; 4) Abitare la linea; 5) Pendolari; 6)Tower bank.

Table 5: Analysis of Phase 1

Groups	Main interpretation or character	Analysis
Group 6; 5	Archetypal approach	The border is that line which allows to perceive a difference or even otherness, as frameworks or linear obstacles make evident. Group 1 seems to be more influenced by artistic installation regarding borders and landscape. It is particularly meaningful the choice of Doug Aitken's "Mirage" among the the examples, as to say that a boundaries signals a difference, and the perception of something different allows to increase the knowledge of yourself. Even cataloguing these works in a prevailing "archetypal approach", it is impossible to exclude from these trend an existential reflection on the meaning of borders and boundaries.
Group 2; 3	Existential Approach	A mainly existential approach is rather recognizable in Group 2 and 3.In one case the motto reports: "The border is the antithesis where limit and union coexists"; in the other: "it is more that which unites than which divides". Both the groups focused on an idea of border as a place of meeting, that is a place where new things can happen and new relationship can grow.
Group 4; 1	Phenomenological Approach	Proposal adhere to a phenomenological approach and adopt and wide the line transforming it into a new livable space, and a place for some different experiences (group 6).

3.3.2. PRESENTATION II (ARCHITECTURAL PROPOSAL)

October 4th, 16.00 - 17.00

From phase 1 to phase 2, a few groups demonstrated to advance consistently, a few others evolved the project according unpredictable directions, or simply excluding aspects which may have guaranteed a more different result, with risks and meanings.

Considering the process in its brief but dense experience, architectural proposal reflects weaknesses and strengths which can be summarized as following:

- **I.** the original idea finds neither an object nor an experience in which to exemplify. Thus the project does not find a mediator or a paradigm by means of which it could be modulated, starting to produce situations. This is the case of the most radical distance between intentions and their relapse. Final objects are not able to recall their noble origins and, remaining alone without a meaning that can be glimpsed in them, they appear empty and unjustified.
- II. In other cases, a strategy for concretizing the idea is intuited and practiced, but rather per replication and not via articulation thus creating a monotonous architectural result, incapable of transferring the richness of the overall original intention. (a stenosis in the compositional paradigm)
- **III.** In other cases a specification intervenes upstream in the process and it is the the amplitude of the concept that inspired the intervention to be reduced and specialized. This operation can be favorable where the original concept proves to be too broad and therefore vague. In other cases it can lead to too specialized and univoque architectural proposals.
- **IV.** Elsewhere shortcomings have other roots and are related to the compositional process itself, where it inevitably induces to make choices between the formal definition of the proposal and the extension/amplification of its contents. This issue is linked also to representation methods, whose mastery becomes incisive, not only in terms of time but also in terms of creativity, since only when a tool is used as a proper prolongation, is possible to concentrate on its results. In the perfectionism of the formal aspect there is thus a constraint of the ideational aspect which is then suffocated.
- **V.** Finally, other project weaknesses have to be founded in the lack of control or knowledge of the final physical elements by means of which they will be realized.

The knowledge and control of the material qualities of architecture can become generative of new circumstances by which to amplify the concept from which the project started.

The STEAM intersection is therefore not only the cradle of the architectural project, but also the matrix by means of which an architectural process can be judge.

Among former considerations, I, II, III refer to the A(rt), IV to E(ngineering) and T(echnologies), V to S(cience) and T(echnologies) again.

Now, the fact that this workshop had a short duration and, especially, required just a preliminary design, led to emphasizing the germination phases of the project, that is those of a more conceptual nature. In these, the goodness of the projects is rewarded by the clarity and coherence of the conceptual framework, hence the weight of the "artistic" or even "philosophical" component of the process.

It is not by chance that it is precisely in relation to the artistic or speculative component that the students have shown to recognize their most important lack in their training, as it will be demonstrated in the following chapter by self-assessments conducted through a pre and post survey.

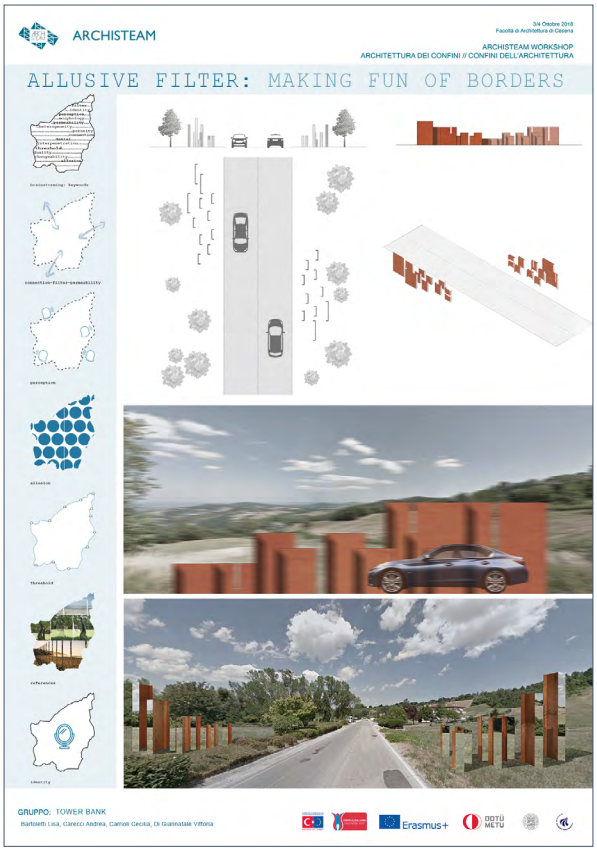


Figure 23: Poster of the architectural proposal of Allusive Borders group (1)

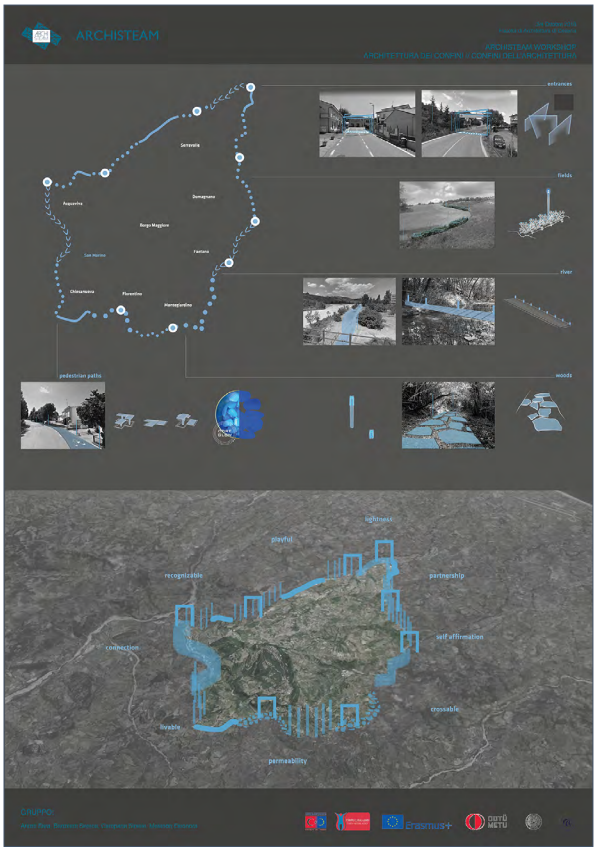


Figure 24: Poster of the architectural proposal of Borderline group (2)

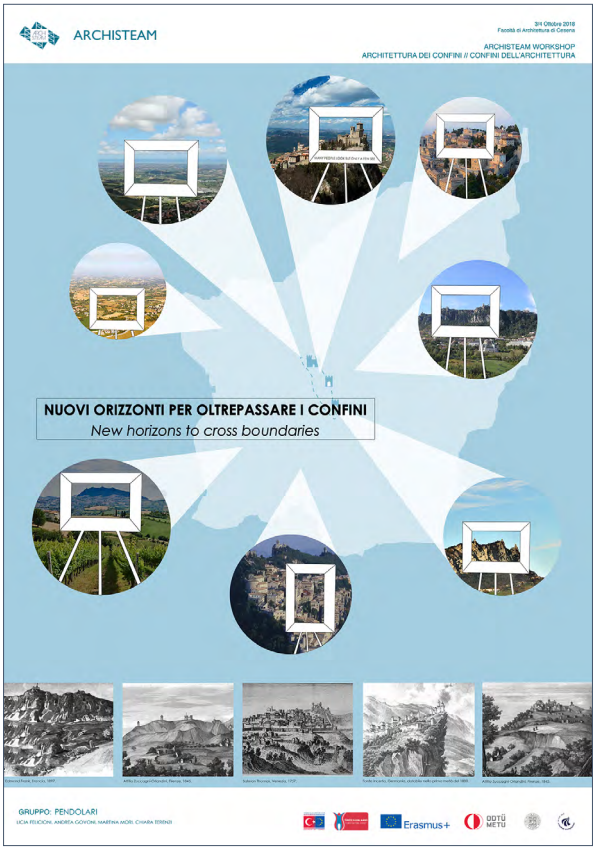


Figure 25: Poster of the architectural proposal of Il cielo sopra San Marino group (3)

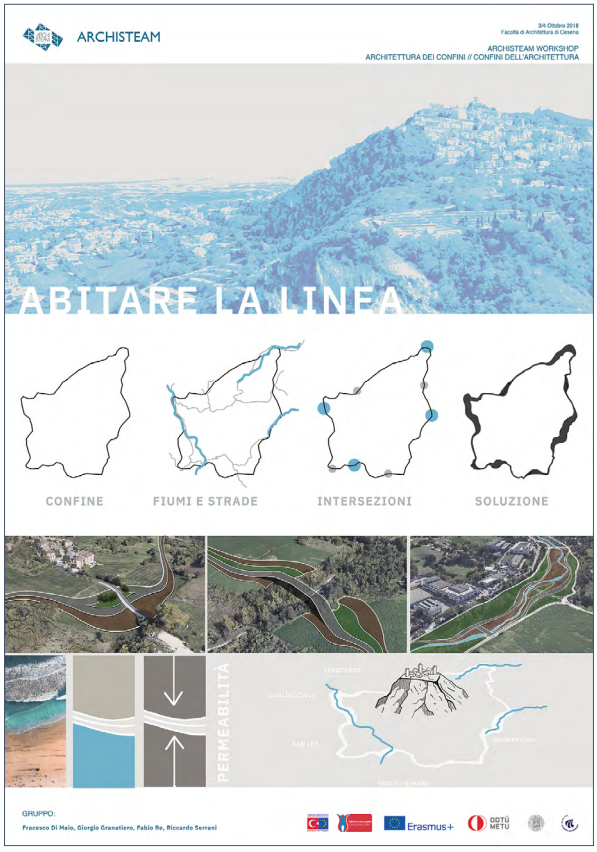


Figure 26: Poster of the architectural proposal of Abitare la linea group (4)

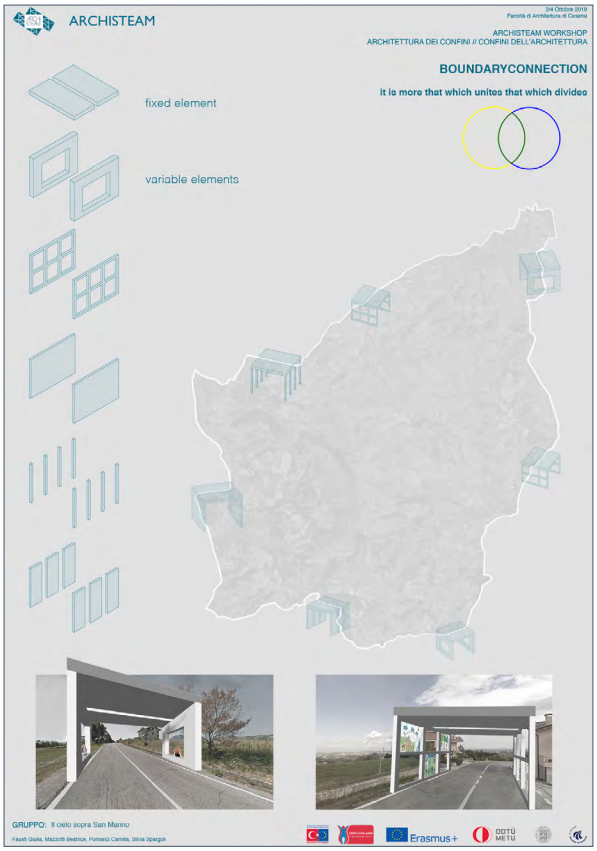


Figure 27: Poster of the architectural proposal of Pendolari group (5)

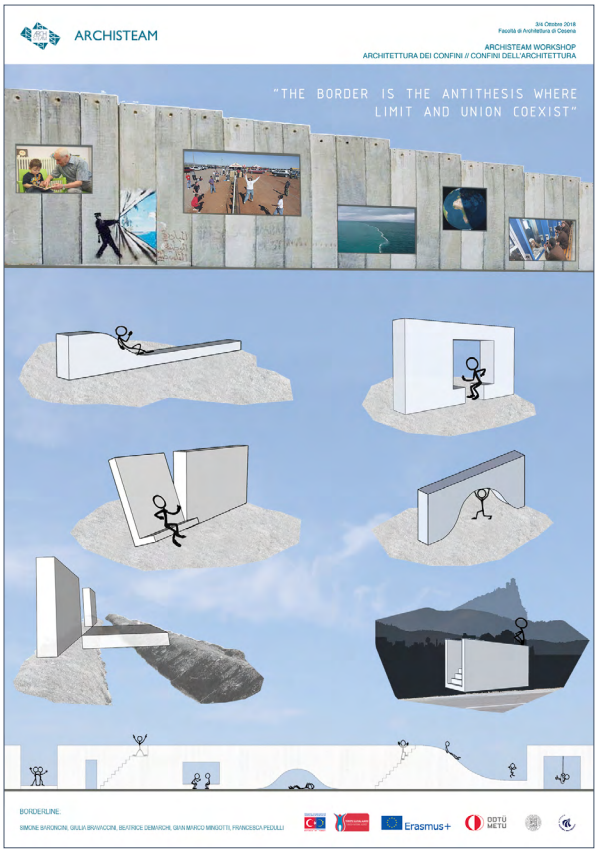


Figure 28: Poster of the architectural proposal of Tower bank group (6)

3.4. Survey

3.4.1. PRE-SURVEY

Aim

The aim of the survey is to investigate the role of Science, Technology, Engineering, Art, Maths in the learning and design processes of students, but also to understand the importance that they give to these subjects before undertaking the workshop: that is to say, in the light of their previous design experience, supposedly undertaken within their "comfort zone".

The questionnaire was shared with all the participants via Google Forms, asking them to fill in the form anonymously, before and after the workshop.

The structure of the survey

The survey consists of two parts: a pre-survey and a post-survey. The same questionnaire had been provided to students before and after the workshop. Hence, two answers for each participant were collected.

As students were all from Italy, Italian was chosen as language for the questionnaires.

The questionnaire is made up with 47 questions which address the influence, the importance, the consideration of STEAM in students approaching design.

The questions are formulated as statements related for example to self-assessment, general consideration, personal judgment, self-reflection and ideas.

Several skills are investigated, as self-learning approach, discipline and auto-organization, problem solving, team work, in line with the STEAM skills emerged from the previous outputs of ArchiSTEAM project.

The redundancy method is adopted in order to better understand the firmness of answers. This means that students are provided with subsequent questions with roughly the same content, but with inversion or shift in the subject, for example from passive to active sentences. For example:

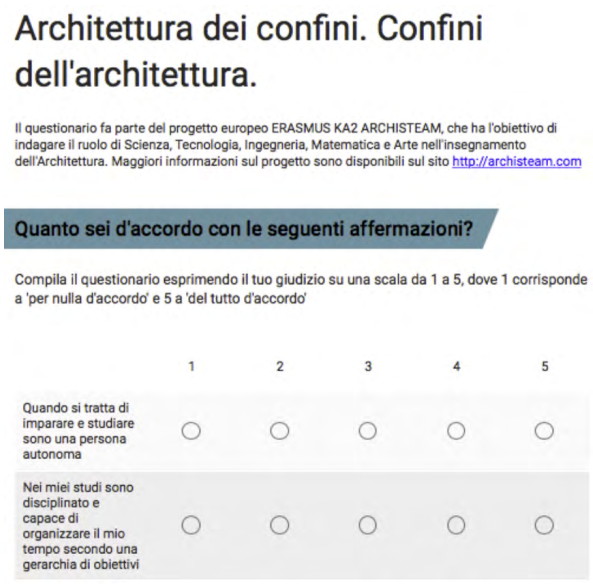
Question 5

"I do think that the architectural project requires the knowledge and the application of Math".

Question 7

"A basic knowledge of Math is enough for approaching an architectural project."

Participants have been asked to answer on a 5-point scale which states how much does one agree to the statement: where 1 means "I totally disagree" and 5 "I totally agree".


Architettura dei confini. Confini dell'architettura.

Il questionario fa parte del progetto europeo ERASMUS KA2 ARCHISTEAM, che ha l'obiettivo di indagare il ruolo di Scienza, Tecnologia, Ingegneria, Matematica e Arte nell'insegnamento dell'Architettura. Maggiori informazioni sul progetto sono disponibili sul sito http://archisteam.com

Quanto sei d'accordo con le seguenti affermazioni?

Compila il questionario esprimendo il tuo giudizio su una scala da 1 a 5, dove 1 corrisponde a 'per nulla d'accordo' e 5 a 'del tutto d'accordo'

	1	2	3	4	5
Quando si tratta di imparare e studiare sono una persona autonoma	○	○	○	○	○
Nei miei studi sono disciplinato e capace di organizzare il mio tempo secondo una gerarchia di obiettivi	○	○	○	○	○

Figure 29: Extract of the survey. The first two questions are presented.

3.4.2. POST-SURVEY

The aim of the post-survey is to track if and how the importance of STEAM has changed for students, after confronting with a theme out of their "comfort zone". Hence, how their considerations about STEAM may have changed after approaching a design topic strictly connected with other disciplines (Social Science, Politics, ecc.).

Hence, the same questionnaire was shared with students, who were asked to reflect about the questions right after the two-day workshop.

3.4.3. RESULTS AND DISCUSSION

Pre-survey

In general, the results of the survey raise quite interesting reflections. The table below shows the mean of the results for each question.

	Questions	Results
Q1	I am autonomous in studying	4,23
Q2	I am disciplined and able to organise my time according to priority of objectives	4,00
Q3	When I study I myself impose objectives and I have a high degree of initiative and motivation to start	3,96
Q4	I am able to organise effectively my time in order to fulfill the tasks I self-imposed	3,76
Q5	I do think that the architectural project requires the knowledge and the application of math	3,11
Q6	I feel to be prepared enough in subjects related to math for what concern the architectural project	3,11
Q7	A basic knowledge of math is enough to the architectural project	2,77
Q8	The architectural project does not involves math	1,61
Q9	The architectural project involves as much geometry as math	3,00
Q10	The architectural project requires a good knowledge of geometry	3,73
Q11	The architectural project is an art action	3,65
Q12	The architectural project is a technological process	3,65
Q13	I do not believe the architectural project to be an artistic-creative product	1,61
Q14	I feel close to art and the creative sphere when I design an architecture	3,76
Q15	In comparison with my design activity, my proximity to the art and creative sphere is enough	3,42
Q16	I do think that the knowledge about art and creativity, which derives from previous education, is enough to the architectural project	2,88
Q17	I take advantage of every art course provided by the university in order to enrich my knowledge	3,65

	Questions	Results
Q18	I do think that being involved in the art and creativity field is key to facilitate my architectural design.	4,07
Q19	An approach too much focused on the artistic quality generates products unsuitable to the functional necessity	3,38
Q20	I often attend events, museums and art exhibition	3,69
Q21	I do not think that attending museums, exhibition and artists can affect my architectural project	1,34
Q22	The architectural project is strongly affected by technological and engineering knowledge	3,65
Q23	I do think that the technological and engineering knowledge provided by university can be enough to the architectural project	3,19
Q24	To do an architectural project requires a degree of technological and engineering knowledge that i do not always have	3,65
Q25	In the design process many professionists are necessary, some specialised in art, others in engineering	4,26
Q26	Studies on biology and nature are not very relevant to the design process	2,15
Q27	Basic knowledge in biology is enough to the architectural project	3,11
Q28	I do think that having a better knowledge of Biology could have changed my approach to the project	2,57
Q29	I do think that human sciences (philosophy, literature, social science) are key in the architectural process	3,80
Q30	I do think that the master course I have attended/am attending provided my enough knowledge in terms of human science	2,34
Q31	I think that the pre-university knowledge in human science is more than enough to the architectural project	2,46
Q32	The architect should be a humanist	3,34
Q33	It seems to me that the knowledge in literature and philosophy are not very helpful in the architectural process	1,96
Q34	Architecture requires mostly a technological and constructive domain	3,11
Q35	If I have to design, I prefer to do it alone	2,03
Q36	The team work limit the design approach	1,34
Q37	I do think that the team work and its dynamics can enrich the project	4,38
Q38	I think to be able to manage tools and practices to the participatory design	3,84
Q39	The master course that I have attended/am attending provided me enough means to manage participatory planning activity	3,88
Q40	The master course that I have attended/am attending provided me sufficient means to solve issues emerging into a team work	4,00
Q41	The quality and knowledge necessary to design in team derives from experiences external to the university	2,73
Q42	The design experience is limited by team work	1,42
Q43	The only way to solve a project is to deal with it in team	2,88
Q44	I do think to be able to approach the design process especially thanks to the abilities acquired during the bachelor/ master course	3,73
Q45	I never feel very firm in approaching a new project	2,73
Q46	The qualities that allow you to face a new project with serenity are not acquired at the university	2,65
Q47	All in all, I am satisfied with the bachelor/master course I chose	4,15

The yellow box highlight questions at which students replied quite firmly. Thus, these answer are considered very interesting and representative.

Interestingly, what emerges is that in mean:

- Students feel to be good at self-organising, self-timing and giving themselves tasks to fulfill.
- Math is regarded an important subject, but not key (the mean of math questions is about 3).
- Art and technology are regarded as slightly more important to the architectural project than math; science is considered slightly less important than math.
- Students feel to be quite prepared on arts and creativity fields, and they think to attend artistic events is key.
- Students feel not to know enough about technology and engineering to properly design an architecture.
- Human sciences are regarded as very important, but students feel not to be provided satisfying education about it, both in previous and current courses.
- Teamwork is in general better than solo work and students feel at ease with it
- All in all, students are satisfied with the education provided them by University

Post-survey

For what concern the differences among pre and post survey, it is necessary to say that data are difficult to compare because the first questionnaire was filled in by 26 students, the former only by 16 of them. However, as the survey are anonymous, the result can be commented in terms of quantitative differences in the means (obviously the results can be compromised by the lack of 10 students).

From this, some consideration can be drawn, especially by observing the greater variations after the workshop experience (darker yellow):

- students realise to be less prepared in math-related subjects than previously thought (Q6);
- the same with art and creativity domains (Q15);
- variation in Q19 strength the idea that following artistic idea and creativity can generate also products suitable to the functional necessity
- Q30 evidences that students recognise the value of knowledge provided them by university in the field of Human Science.

Table 6: Comparative analysis of post and pre surveys

Q1	4,23	3,93	0,3
Q2	4	3,81	0,19
Q3	3,96	3,5	0,46
Q4	3,76	3,5	0,26
Q5	3,11	2,87	0,24
Q6	3,11	2,56	0,55
Q7	2,77	2,43	0,34
Q8	1,61	1,43	0,18
Q9	3	2,87	0,13
Q10	3,73	3,43	0,3
Q11	3,65	3,68	-0,03
Q12	3,65	3,43	0,22
Q13	1,61	1,5	0,11
Q14	3,76	3,87	-0,11
Q15	3,42	2,87	0,55
Q16	2,88	2,56	0,32
Q17	3,65	3,18	0,47
Q18	4,07	4	0,07
Q19	3,38	2,75	0,63
Q20	3,69	3,31	0,38
Q21	1,34	1,37	-0,03
Q22	3,65	3,25	0,4
Q23	3,19	2,87	0,32
Q24	3,65	3,31	0,34
Q25	4,26	3,93	0,33
Q26	2,15	2,56	-0,41
Q27	3,11	2,87	0,24
Q28	2,57	2,81	-0,24
Q29	3,8	3,81	-0,01
Q30	2,34	3	-0,66
Q31	2,46	2,37	0,09
Q32	3,34	3,43	-0,09
Q33	1,96	2,06	-0,1
Q34	3,11	2,68	0,43
Q35	2,03	1,87	0,16
Q36	1,34	1,5	-0,16
Q37	4,38	4,5	-0,12
Q38	3,84	3,68	0,16
Q39	3,88	3,81	0,07
Q40	4	3,81	0,19
Q41	2,73	2,87	-0,14
Q42	1,42	1,56	-0,14
Q43	2,88	3	-0,12
Q44	3,73	3,68	0,05
Q45	2,73	2,81	-0,08
Q46	2,65	2,37	0,28
Q47	4,15	3,93	0,22

Legend

$<|0,2|$ no difference

$|0,2| < x < |0,5|$ slight differences

$> |0,5|$ significative differences

4. SITE SPECIFIC WORKSHOP @Aalborg University, Denmark

4.1. Introduction

4.1.1. THEME

The Aalborg University workshop was organised as an interdisciplinary design workshop with a duration of one day. As the professional profile of the workshop participants spanned a host of design disciplines ranging from industrial design over architectural design to urban design, the brief was broadly formulated.

Hence, the participants were asked to design "an object or a space of any size, shape and function", which had to "relate to the potential of the site and address a problem which may be meaningfully addressed through an intervention on this site" (workshop brief).

In the workshop, the participants were asked to do a conceptual design for a small inner-city site. For matters of convenience, a site was chosen close to the campus where the participants worked. Within the confined length of the workshop, this allowed for site visits, which were an important part of the brief.

Assignment

On the basis of a brief introduction to the assignment, the site and the concept of STEAM, participants were asked to form groups of three on the basis of their self-perceived STEAM skills. Immediately after that, the participants were asked to start working on the assignment.

What are the concerns choosing the problem

The project brief was carefully designed to address not only the concrete design of a physical artifact, but also to have the participants reflect on both on how the artifact was situated in the physical and geographic, socio-economic and cultural contexts of the site.

How it is related with the STEAM approach

The participants were explicitly asked to consider these contexts in the light of their combined STEAM skills and to reflect upon how they could address the design problem through the application of their STEAM skills.

4.1.2. WORKSHOP TEAM

Due to scheduling constraints, it was not possible to match the timing requirements of the participants and the timing constraints of the project partners. Therefore, the workshop had to be conducted by the Aalborg University team alone.

4.1.3. PROGRAM

The workshop at Aalborg University was conducted as an intensive one-day workshop with a program spanning a full day from 10.00 to 17.00 as shown in the timetable in the following.

Details of the program

The program for the one-day workshop was composed as follows:

10:00 Introduction by associate professor Nicolai Steinø
10:15 STEAM assessment exercise and group formation
10:45 Project work supervised by Nis Ovesen and Nicolai Steinø
12:00 Lunch
13:00 Project work (continued)
15:50 Poster hand-in
16:00 Presentations and evaluation
17:00 End of program

In the structuring of the program, emphasis was put on enabling the workshop participants to engage in the given task as fast as possible. Therefore the introduction to the task was kept short and precise. An equally important part of the AAU workshop was the group formation, which was based on the participants' respective STEAM skills. In the program, time for the group formation was therefore prioritised. The formation process was also carefully planned and firmly facilitated by the workshop facilitators.

The program was furthermore organised in a way that gave maximum time for the groups to solve the task given. As part of these considerations, the

site for the task was selected with respect to this and therefore nearby.

All participants were new to Aalborg University and did not have the opportunity to register for general campus services such as internet and printing. Therefore, participants were asked to use predominantly manual design techniques and to submit their proposals in the form of physical montage posters.

As the workshop participants was newly enrolled to Aalborg University, he workshop was primarily announced online via the university communication channels such as Moodle, which is the primary learning management system at Aalborg University. The participants was also informed about the workshop via direct e-mail from the Architecture & Design Study Board at AAU. The workshop was furthermore announced online on the project website archisteam.com and finally with physical posters at campus.

4.2. Conditions for the selection and preparation of a Experiential Learning Environment

4.2.1. PARTICIPANTS

Applications

The workshop was offered to students admitted into the Aalborg University Architecture and Design MSc program for the 2018 Fall semester who had not completed their BSc degrees in the Aalborg University Architecture and Design BSc program. This constituted a body of 54 potential participants. Out of those, 25 students participated, This constituted 46% of the base.

Eligibility criteria

The workshop formed part of a larger program of introductions to new students to problem-based learning and group work as practiced at Aalborg University. As such, the eligibility of the participants was filtered through the general admission criteria for students in the MSc program as evaluated by the Architecture and Design program's general admission committee (ADAC).

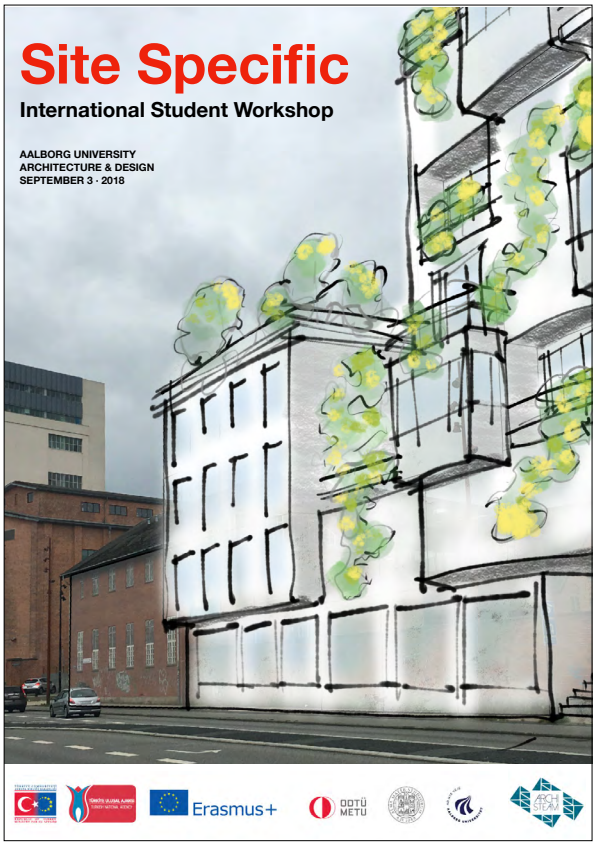


Figure 30: Poster of the Workshop

Profile of the participants

The Aalborg University MSc Architecture and Design program is offered in English and enjoys wide international attention. Therefore, new students to the MSc program typically have very versatile backgrounds, both geographically and with respect to their BSc profiles. Hence, the workshop had participants from a wide range of countries including China, France, India, Italy, Netherlands, New Zealand, Norway, Pakistan, Uruguay and more.

The Aalborg University MSc Architecture and Design program offers four specialisations; industrial design, architectural design, urban design and mobility design. The workshop participants were distributed across all of these specialisations. They therefore also had versatile BSc backgrounds in fields ranging from architecture, urban design and urban planning over mobility studies to real estate. Hence, they also represented many different STEAM skills.

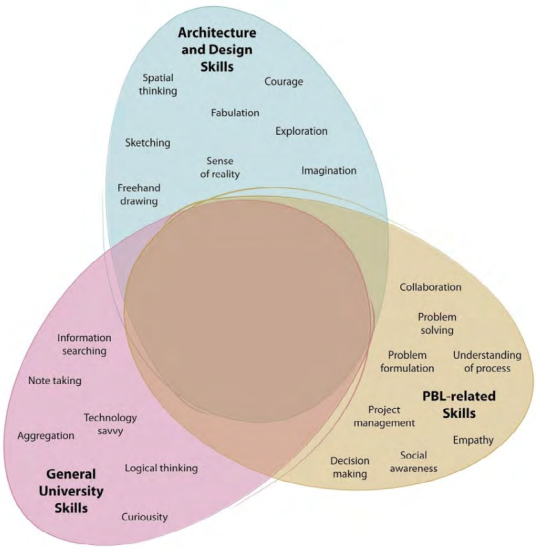


Figure 31: Baseline skills in a PBL university setting

4.2.2. CRITERIA FOR THE EXPERIENTIAL LEARNING SCENARIO

As for the Aalborg University workshop, problem-based learning is one of the main drivers and criterias for the experiential learning scenario. From that perspective, it has mainly been the baseline skills in a PBL university setting that has been in focus for the workshop. Hence this, the chosen criteria for the experiential learning scenario was a subset of the full set of PBL baseline skills presented in the report "O3: Adaptation of developed STEAM modules in existing curricula".

The selected subset of baseline skills form the set of criterias for the experiential learning scenario and is presented in the Table 7.

Table 7: Chosen criteria for the experiential learning scenario at Aalborg University

Skill indicator	Learning Outcomes
General University Skills	
Information searching	Be able to select the proper sources for the search Summarize and conclude the search
Aggregation	Be able to proportionally evaluate the significance of elements relative to each other
Curiosity	Be able to see learning as a goal in itself Be motivated to seek information out of one's own initiative
PBL-related skills	
Collaboration	Be able to establish a common understanding of a certain task Be able to organise work between multiple individuals in order to solve a certain task Be able to optimise own and others work by sharing individual work to a common result
Problem formulation	Understanding the dualism between a problem and solution space Be able to identify a problem Be able to clearly formulate the problem
Problem solving	Be able to define criteria for a viable solution Be able to develop proposals that corresponds with the criteria for solving the problem
Decision making	Be able to evaluate concepts and solutions that solves specific problems
Social awareness	Know basic social rules and behaviour Understand and comprehend a social situation effectively
Architecture and design-related skills	
Freehand drawing	Be able to apply drawing tools and techniques to freehand drawing
Sketching	Be able to apply drawing/modeling skills in the process of sketching Be able to evaluate sketches as a basis for new sketches
Spatial thinking	Have a sense of three-dimensional space Be able to analyse spatial situations
Sense of reality	Be able to analyse proper needs
Explorative spirit	Have the perseverance to perform repeated cycles of trial and error Be able to apply unconventional concepts, methods and techniques to problem solving
Courage	Dare to venture into the unknown
Imagination	Be broad in insight and outlook Dare to fabulate
Fabulation	Be able to let thoughts wander Be able to let fantasy form ideas

4.2.3. PREPARATION PHASE

4.2.3.1. ASSESSMENT CRITERIA FOR THE ASSESSMENT OF THE EXPERIENTIAL LEARNING ENVIRONMENT

As baseline skills are predominantly soft (qualitative) skills, they cannot be evaluated against hard (quantitative) criteria. Therefore, baseline skills can only meaningfully be evaluated by way of performance-based assessment. In practice this meant that the assessment took place predominantly through dialogue, i.e. oral assessment.

In order to qualify the oral assessment in the workshop, a series of various teaching and learning activities shown in table 8 below were integrated into the workshop design.

Table 8: Teaching and learning activities

Teaching and Learning Activities	Assessment
Direct Instruction Inductive investigation and inquiry Design and problem solving Partner and group collaboration Indirect teaching Role modeling Self-reflection	Oral assessment of the learning outcomes based on assignment with evaluation of learning activities

As an example the skills "collaboration" and "social awareness" were exercised on the basis of a instructor facilitated group formation process and eventually orally evaluated in the group presentations based on the groups' self-reflections.

Another example shows how the skills of courage, imagination and fabulation were activated as they were a necessary part of the problem solving. A direct instruction in the assignment was that the solution should be radical and bold, which necessitate a certain amount of those exact skills mentioned. Once again, these skills were evaluated through discussing the boldness of the groups' respective proposals.

4.2.3.2. PRE-SURVEY

Despite the fact that a pre-survey could have been beneficial, it was not possible to conduct such survey. This was partly due the the timing of the workshop, but also because of the fact that the participants were not present at the university campus prior the day of the workshop. Hence this, it was not possible to give the necessary instructions and contextual knowledge needed for them to fill in the pre-survey.

4.2.3.3. CONDUCTION APPROACH

Grouping

The participants were freshly admitted to the Aalborg University Architecture and Design program. They therefore had no prior knowledge of, nor any collaboration experience with, each other. Thus, the formation of functional work groups was a crucial prerequisite to a successful outcome of the workshop.

As part of the introduction to the workshop, the participants were introduced to the concept of STEAM. In the course of a joint brainstorming session, the participants were asked to share their perceptions about their personal STEAM skills, as well as STEAM skills pertinent to the different professional profiles that they represented. Particular emphasis was put on the fact that design disciplines are typically hybrid, in and of themselves, with respect to their embedded STEAM skills.

As the workshop participants came from many different design and training backgrounds, their STEAM skills were mapped through self-evaluation as a basis for forming the project groups that they would be working in. All participants was asked to map their primary and secondary STEAM skills. Groups then had to be formed so that as many STEAM skills as possible were represented in all groups, allowing for the most integrated design approach possible.

The practical implementation of this exercise was conducted as a physical exercise involving haptic-kinesthetic learning. Each equipped with two small pieces with printed S-T-E-A-M letters in capital and small print for their primary and secondary STEAM skills respectively, they were invited to come to a room with a large floor space. On the floor, tiles with the letters S-T-E-A-M and s-t-e-a-m respectively were laid out to form an imaginary matrix with letters for rows and columns.

The participants were asked to figure out by themselves what to do and to act accordingly, once they did. Most participants quickly positioned themselves in the matrix in correspondence with

Figure 32: Participants position themselves in the STEAM-steam matrix in correspondence with their perceived primary and secondary STEAM skills.

the letter pieces in their hands. (Figure 32). Once distributed, the participants were asked to form groups of three in such a way that – to the extent possible – no two participants were recruited from the same column, nor from the same row, so as to guarantee the highest possible distribution of primary and secondary STEAM skills possible.

Mentoring, Assessment and Rubrics - Measurement, Evaluation

A fundamental tenet of tutoring within the problem-based learning (PBL) approach is to make the students reflect upon their own problem definitions as well as on the solutiones they devise to address them. In doing so, the basic strategy is to ask questions about the students' reasoning rather than to give answers, whether professional or normative.

This is a very contextual tutoring technique, as it always takes the students' own work as it s point of departure. It is therefore based on a didactics which operates on a meta-level rather than from specific protocols. Nonetheless, while it may seem more fluid and less structured, its aim is as specific and rigorous as within more formalised approaches.

Throughout the workshop, the PBL tutoring approach was adopted, focusing on five particular questions:

- How does your design relate to the potential of the site and address a problem which may be meaningfully addressed through an intervention on this site?
- How do you read the site a) narrowly in the physical context of the street and urban block, as well as b) broadly in the city of Aalborg, the region of North Jutland and the country of Denmark?
- What is the nature of the problem which you seek to address through your design, to whom is it relevant, and how can it be meaningfully addressed by means of design at the chosen scale?
- How does the proposed design relate to the physical, cultural and socio-economic setting of the site as you understand and define it.
- How radical/bold is your design?

The first question is a very fundamental design question addressing the relevance of design ideas in response to the nature of the problem which is addressed by the design and how, as well as potential which the particular site has for devising the design solution in question. Reflections on this should be constant and iterative throughout the design process.

The second question addresses the notion of context, both architectural, physical and cultural. The immediate scale of the site is architectural. At this scale, the participants should understand the morphology, architecture, spatiality and flows of the space, as well as its spatio-temporal location

within its immediate surroundings. At the regional scale, participants should be able to identify the demographic, climatic, and infrastructure factors which condition the site. And on the national scale, aspects of culture, wealth and political organisation is of the essence.

The third question has both social and ontological implications. On the one hand, it asks for the meaning of the design. To answer this requires both knowledge of alternative design solutions – possibly at other scales – and of whether design is at all the right domain for addressing the problem at hand. On the other hand, it asks to whom the design is meaningful, thus forcing the students to emphatically reflect upon the fact that not all humans share the same needs and interests.

The fourth question is open ended as it invites the students to recognise that design is both normative and argumentative in the sense that both design and problem definition are normative and subject to subjective interpretation. It also invites and integrated view of the site as not only conditioned by its physical characteristics but also by its history, use and potential for different uses and users.

The final question addresses the design spirit of the designer. From a merely functional point of view, most design problems may be sufficiently addressed through modest and bashful designs. In order to encourage the participants to consider the artistic quality of their designs, this question aims to make them reflect how their designs may achieve more than merely address the functional requirements of the design.

Actions for provoking creativity

While mostly cherished as an artistic quality, creativity is not only important in design development, but also in the other parts of the design process. Adopting a creative, explorative and playful attitude is also important in the more 'dry' parts of the design process such as empirical and theoretical studies. Hence, adopting an integrated – and hence a STEAM – approach to these other phases may contribute to more artistic results. Thus, encouraging creativity throughout the design process is an important aspect of successful supervision.

The one-day format of the workshop leaves little room for meticulous analysis and contemplation. Thus, in order to achieve a design result within such a limited time-frame, it is important to consider possible design strategies from the first minute. This requires a creative frame of mind. In the introduction to the workshop as well as throughout the supervision sessions with the work groups, this was encouraged and stimulated both through the required actions according to the workshop program, and through conversations.

4.2.3.4. POST WORKSHOP EVALUATION

Aim

A post workshop evaluation was conducted after the workshop to evaluate to what extend the AAU workshop had been a successful learning experience for the participants. The aim was furthermore to get feedback from the participants on the workshop format and on how it was conducted in practice.

The structure of the evaluation

As the aim of the post workshop evaluation was twofold, so was the structure of the evaluation. The first part of the evaluation was organised as project presentations with comments and discussion. The second part was a plenary discussion on the workshop format and conduction.

In the project presentations design quality and conceptual quality was evaluated through discussions and questions from the workshop team and the audience of other workshop participants. However, the presenting group also made a self evaluation based on their cumulative STEAM competences by evaluating the resulting project with respect to the group's upper-case (primary competences) and lower-case (secondary competences) letters. This exercise made the participants reflect on to what extent they had utilised all the competences and thereby full potential in the group.

The plenary discussion of the workshop format and conduction was an open discussion among the participants and the workshop team. The workshop team asked open questions to the participants in order to initiate a free discussion about both how to improve the workshop and what to leave as it was.

4.3. Experiential Learning Environments: Design-Implementation-Assessment Processes

4.3.1. OUTCOMES AND ASSESSMENT CRITERIA

As part of the introduction to the AAU workshop the criteria for the assignment was fixed in accordance with the time and tools available to the participants. As described earlier, the participants was asked to produce a conceptual design for a site in Aalborg, opposite the campus building. They were furthermore asked to work collaboratively in groups of three, while drawing from their collective STEAM skills. As criteria for the physical outcome of the workshop, the following requirements were given for the assignment:

- Your design must be for an object or a space of any size, shape and function. But it must relate to the potential of the site and address a problem which may be meaningfully addressed through an intervention on this site.
- The site should be understood both narrowly as the street or urban block, as well as broadly as the city of Aalborg, North Jutland and Denmark.
- The problem should be of relevance to a well-defined group of people and of a nature which can be meaningfully addressed by means of design at the chosen scale.
- The proposed design must relate to the physical, cultural and socio-economic setting of the site as you understand and define it.
- The design must be bold, meaning that radical designs are prefered over modest designs.

The participants were also given a specific format for submitting the workshop output, which is presented in Table 9.

In the development of the criteria, emphasis was put on enabling the participants to submit satisfactory workshop outputs with the use of only manual tools and techniques as digital tools and production equipment was not part of the guaranteed workshop facilities.

Three examples of the submitted workshop outcome are found in the Figure 33-35.

Table 9: Submission requirements at the AAU Workshop

Each group must submit a 100x70 cm poster (landscape format) including the following:

- A main illustration showing the overall design idea. This illustration should be app. 50x50 cm and placed in the center of the poster. This illustration can be a plan, an elevation or any 3D projection.
- A diagram showing the main principle of the design.
- Two illustrations in the projections not chosen for illustration 1.
- An illustration of your own choice.

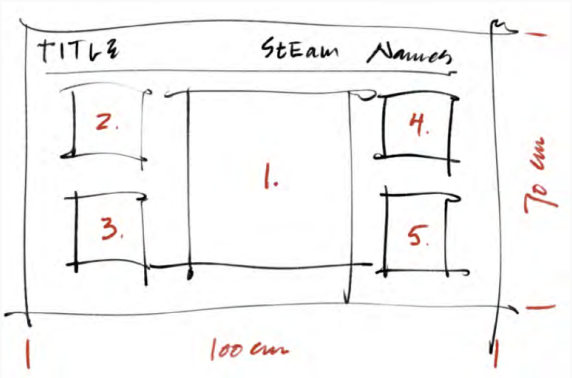
The five illustrations should be organised in the poster as shown in the figure below.

Any graphic techniques may be used, although manual and mixed/collage techniques are encouraged. Original illustrations may be mounted on the poster.

Apart from the illustrations, the following text must be included:

- A title. The title should be short and descriptive of the conceptual design.
- Full names of all contributors.
- The date (dd//mm/yyyy).
- Brief captions (20 words max.) for each illustration.

All text must be in English and in (your best) handwriting.



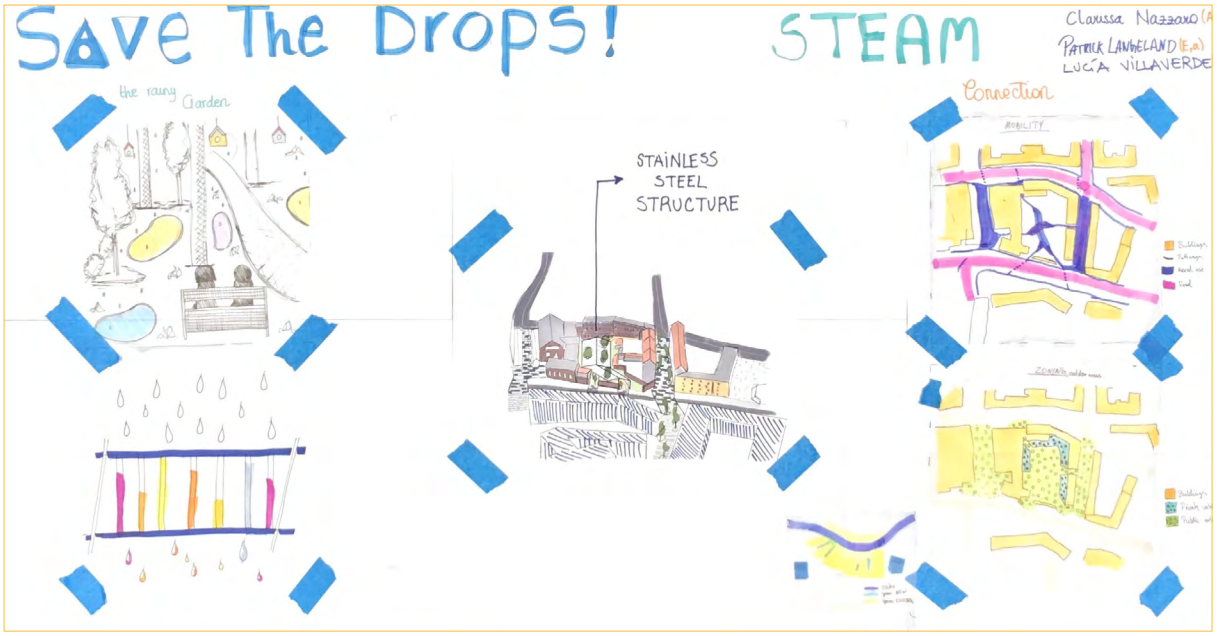


Figure 33: submitted workshop outcome: Save the Drops

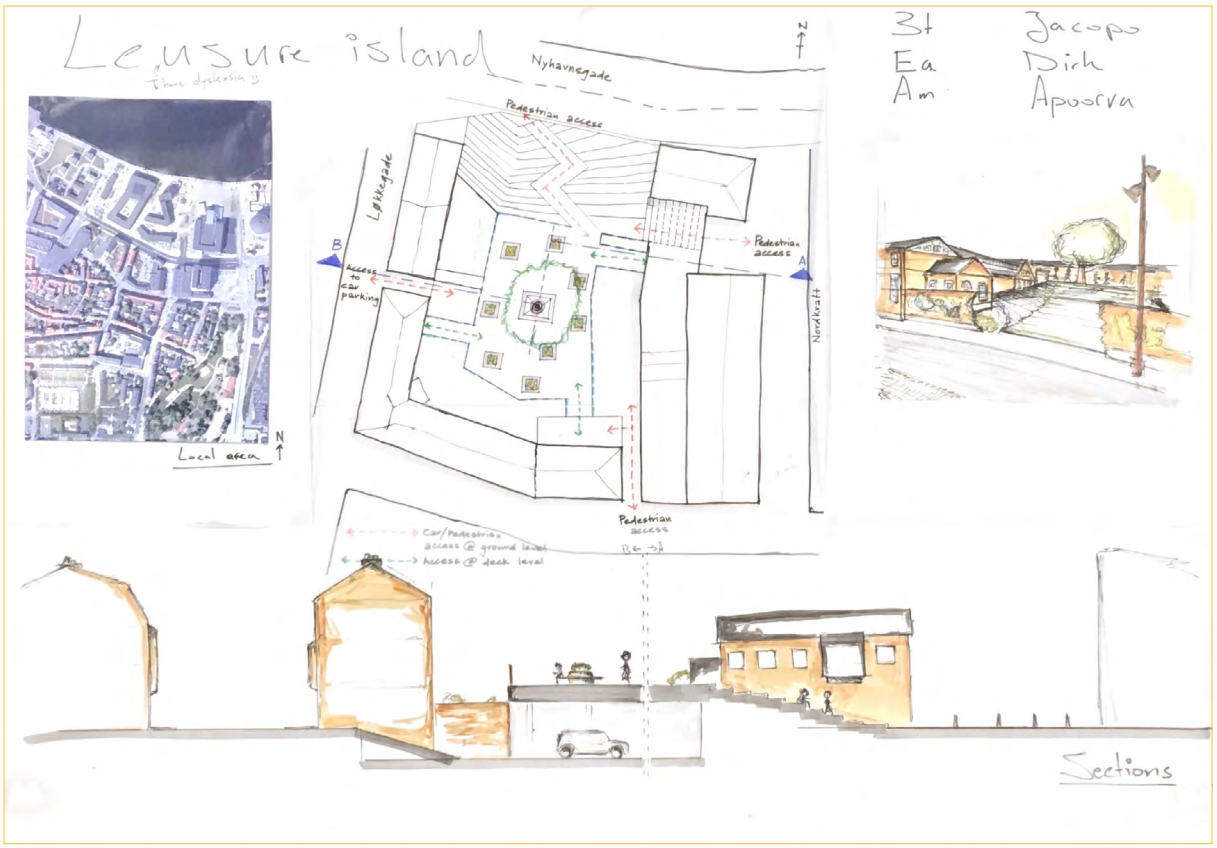


Figure 34: submitted workshop outcome: Leisure Island

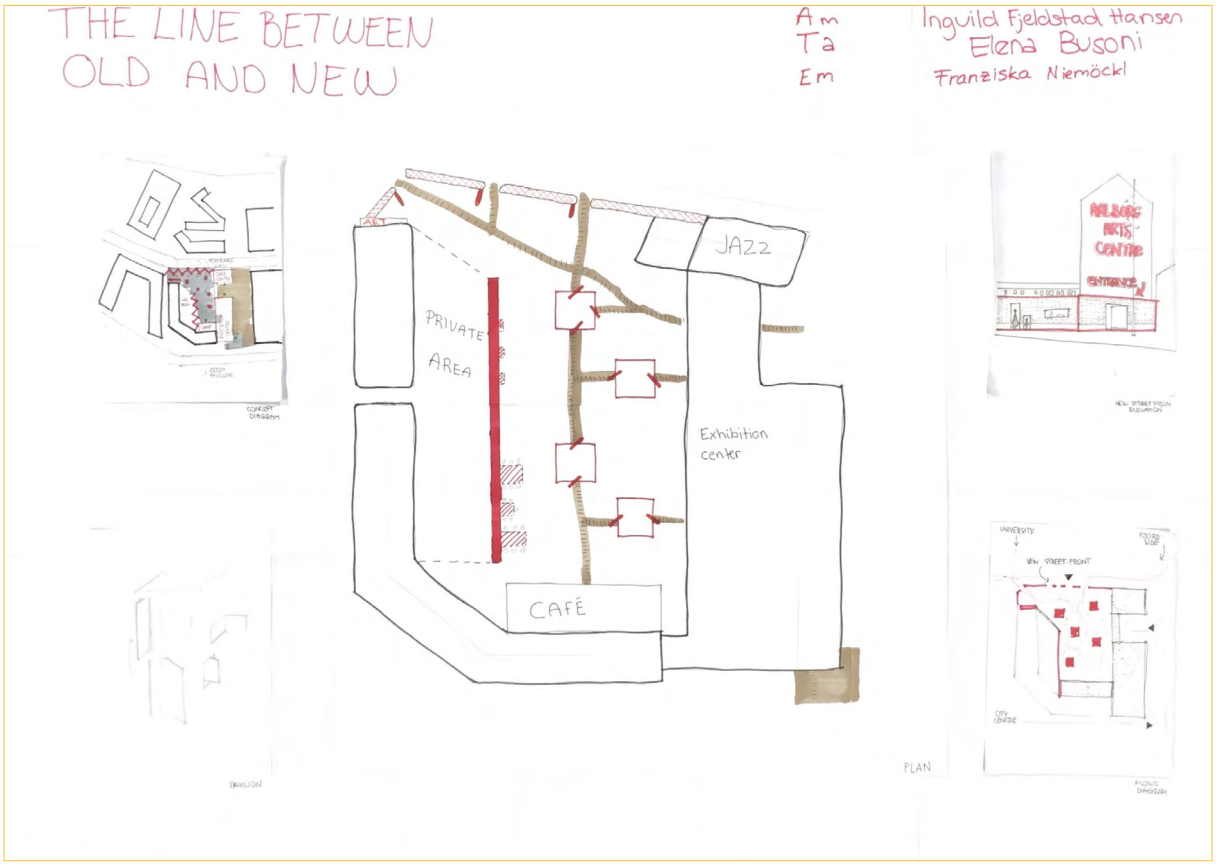


Figure 35: submitted workshop outcome: The Line Between Old and New

With the set of well-defined submission requirements a series of formal assessment criteria was implicitly established: Did the submission fulfill the submission requirements or not? But, more importantly, in addition to this an assessment of how well the submissions adhered to the objectives set in the assignment was conducted through the group presentations in the end of the workshop and the immediately following plenary feedback and discussion. As part of this, the participants was also asked to self-evaluate the group's result in relation to the combination of the participants' joint STEAM skills.

4.3.2. EXPERIENTIAL LEARNING SCENARIO

The experiential learning scenario was built around a typical design problem, also known as a wicked problem. The characteristics of such problem is that it is ill-defined and does not naturally pair up with an easy solution. A wicked problem is situational and not fully fathomable before engaging into it. This means that the problem is understood in the dualistic process of trying to solve it. This type of problem solving activity at the same time fosters creativity and forces experimental approaches.

The assignment given in the the Aalborg University workshop was about developing a design concept to a specific site in the local area. The conceptual solution should be relevant to a specific population or group of people, count in the site in the context of Aalborg, north Jutland or Denmark, and furthermore be bold or radical in its nature. As a paradox, this seemingly precisely defined assignment described in five bullets, results in a very open solution space, and forces participants to further define the problem and gradually become aware of what knowledge is needed. This is the core of PBL (Problem-Based Learning), and drives students - or in this case workshop participants - to go through a series of learning cycles as they collectively develop a viable solution to a gradually emerging problem.

This process resembles the Learning Cycle by Kolb, which is typically defined by four stages: Concrete Experience; Reflective Observation; Abstract Conceptualisation; Active Experimentation. This four-stage cyclic - but forward-moving - process repeats itself and as a result of it learning takes place.

4.3.3. INTRODUCTION OF EXPERIENTIAL LEARNING SCENARIO TO WORKSHOP PARTICIPANTS

The assignment was presented to the workshop participants as part of the workshop introduction. The introduction in the form of a short presentation introduced the design brief, the site, and the notion of STEAM. It also outlined design as a field which is positioned between analysis and design and between problem and solution respectively. The components of the field are skill, experience, knowledge and imagination (Figure 36).

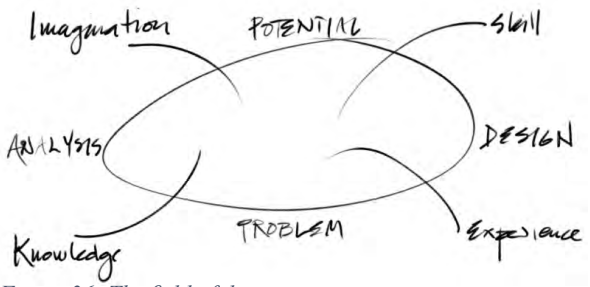


Figure 36: The field of design.

4.3.4. RESEARCH PHASE OF THE SOLUTION

After the introduction to the experiential learning scenario, the workshop participants were grouped into groups of three as described earlier. After the grouping session, the participants went on to discuss the assignment, and in all the cases, the groups found it beneficial to visit the site (which was nearby the campus) as part of this initial research process.

The format of the workshop encouraged the participants to adopt an Integrated understanding of the different phases of design by which all aspects – analysis, design, synthesis – were considered as a whole. This, in fact, is not only the actual approach of many professional designers, but also a very efficient, albeit demanding, approach to design. Hence, the participants were encouraged to sketch and discuss different design solutions from the very outset of the workshop.

In the immediate level, this part of the workshop served the purpose of design development. This however, was merely the vehicle for design learning, which constituted the actual purpose of the workshop. Throughout this part, supervision sessions therefore served the purpose of encouraging the participants to consider their design reflections in the context of the design brief (to 'keep them on track'), as well as to have them consider them in the context of STEAM.

4.3.5. PRODUCTION

The participants were asked to submit and present their design proposals by the end of the workshop. In doing so, they were required to a) reflect the five design questions as described earlier (and as formulated in the workshop brief), and b) to evaluate the STEAM components of their designs, their own combined STEAM skills, as well as their relevance in achieving the design results.

On a more practical note, the participants were required to submit a poster of their conceptual design. The production of posters was forced to happen while the conceptual design was still partly in development due to the time limitations of the workshop. To accommodate this dynamic process, the production was done with fast manual tools and techniques

4.3.6. ASSESSMENT

In order to assess the extent to which the participants were able to perform self-reflection, all participant groups were asked to not only present their designs, but also to reflect upon them and to reflect upon the relevance of their combined STEAM skills in achieving the results. Therefore, no formal assessment was performed during the workshop. Instead, all final presentations were video recorded for subsequent analysis and assessment.

4.4. Implementation

4.4.1. DOCUMENTATION OF MINUTES

The workshop is documented with photos, video footages and outcomes of the projects by means of posters and more. In addition to this report, the images and video are shared via the project website: http://archisteam.com/sitespecific/

As the Aalborg University workshop was conducted as a one-day workshop, the program was tightly structured. Participants arrived to the campus in the morning and was welcomed by the chairman of the Architecture and Design study board. As the participants were new to the campus building, a tour around the facilities were organised with the help of student employees.

Figure 37: Workshop Introduction - Workshop team presents the STEAM concept and the workshop assignment.

After the welcome address and the tour, the actual workshop began with an introduction to STEAM and to the workshop assignment. The group formation was conducted immediately after this introduction as described in above in a previous section.

After the group formation, the workshop participants was asked to discuss the assignment in their new formations and thereby establish a common understanding of the task. All groups found it necessary to start by visiting the site that was only presented in pictures and videos earlier in the introduction. The groups individually organised the trip to the site themselves and returned to the allocated working area after the visit.

Figure 38: Map of the central area of Aalborg showing the city campus (marked with X) and the site that is central to the workshop assignment (marked with a circle).

Figure 39: Workshop participants working in groups on the assignment. Sketching and ideation after visiting the site

Figure 40: Workshop group presenting their project at the end of the workshop.

After the visit to the site, the problems and potentials of the site were discussed in the groups, while the workshop team walked around and both supervised and challenged the groups in their discussions.

The workshop schedule was given to the participants in the beginning of the workshop, and as the deadline for handing in the conceptual proposals came closer, the decision making and material production went on in an increasingly faster pace.

4.5. Results and Discussions

Site Specific was a one-day workshop with a total of 24 participants organised at Aalborg University as part of the ArchiSTEAM project. The participants were asked to design "an object or a space of any size, shape and function", which had to "relate to the potential of the site and address a problem which may be meaningfully addressed through an intervention on this site". In the workshop, the participants were asked to do a conceptual design.

The assignment and the concept of STEAM were presented to the participants, which were asked to form groups of three on the basis of their self-perceived STEAM skills.

The assignment was carefully designed to address not only the concrete design of a physical artifact, but also to have the participants reflect on how the artifact was situated in the physical and geographic, socio-economic and cultural contexts of the site. The participants were furthermore asked to consider these contexts in the light of their combined STEAM skills and to reflect upon how they could address the design problem through the application of their STEAM skills.

Throughout the workshop, the groups were supervised by the Aalborg University workshop team, and by the end of the workshop, each group had produced a conceptual design that were all presented through an oral presentation and evaluated through a discussion among the workshop team and the rest of the workshop participants.

Problem-based learning was one of the main drivers and criteria for the experiential learning scenario at the workshop as Aalborg University is a PBL university. Hence this, focus has been on exercising the baseline skills of a PBL university. Among these, group formation and cross-disciplinary collaboration has been strong focal points in the design of the workshop.

The outcome of the workshop shows that it is possible to establish a strong collaborative effort in a short time by presenting an open an ill-defined problem for participants to work with. It is clear that a one-day workshop is limited in the regards to new professional and technical skills. These requires more time. However, one day with an intensive and tightly organised program can prove to be highly beneficial for the participants as a learning input in a PBL-based university setting.

5. REFLECTIONS

The ARCHISTEAM Project was a two year project aiming to provide the ground to establish a STEAM approach in architectural design education. The STEAM approach is considered as an enabler for architecture students to work in an interdisciplinary way, and to approach design problems in a broadened perspective in their profession. It is also strongly advocated that the STEAM approach brings innovation and creativity into the design process.

Four major issues are pondered within the project; skill sets to be conveyed, assessment of the learning process, features of the learning environment and the idea of modules based on the STEAM approach.

In the course of the project the following issues have been observed:

- Architectural education and especially design education has always been a controversial issue and each school has its own way of structuring their curriculum, and yet what is most common is the implicit implementation of STEAM.

- When the curricula of the schools, including METU, AAU and UNIBO were examined, one of the major problems was to assess "how much STEAM is incorporated" in any course or in any module.

- "What should be the expected skill sets to be conveyed to students in relation to the STEAM approach" is not clear.

- The role of constructivist learning and PBL in the curriculum needs to be further discussed in the realm of STEAM in a more explicit way by most of the universities.

The following issues are discussed in relation with the observation:

- In the field of architecture, three skill sets – ground skills, PBL skills and ICT skills – on top of the professional skills that are gained during education are essential for students, not only in their span of education but also in their professional life. These skills can be considered as green skills for the sustainability of their profession.

- The STEAM approach as a way of structured integration of various disciplines invokes learning experience and furnishes creativity.

- The assessment process and means of assessments are crucial in the learning process in regard to setting the proper PBL environment and supporting the learning process of students.

- STEAM based modules are important means to enhance the learning process. Hence it is important to carefully design such modules within the curriculum.

- A module can span a short period of time or can cover the whole period of education and can be advanced according to the level of students.

- In the modules, the way the problem is assigned to students and the nature of the problem determine the success of the learning process and the integration of STEAM by engaging students more.

The findings of the projects have been implemented in three different workshops conducted at METU, UNIBO and AAU. The subject matters, schedules, settings, etc., were chosen to be different than each other in order to show how STEAM approach can be implemented in different contexts, in different universities in accordance with the existing curriculum. Each workshop is documented and presented aiming to provide an example to show module design based on STEAM to contribute to architectural education in universities and to contribute to have more engaged and open-minded students being able to work from a more interdisciplinary perspective.

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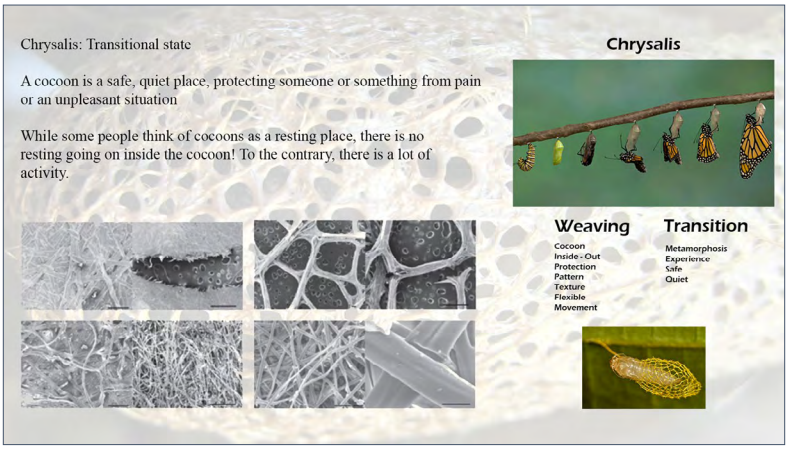
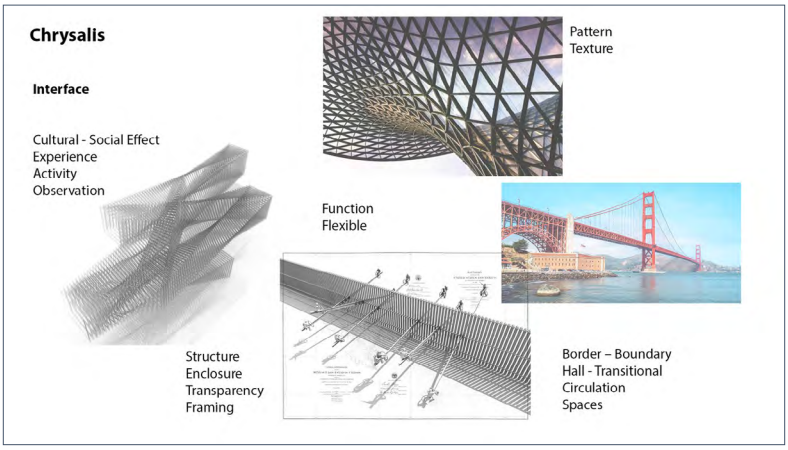
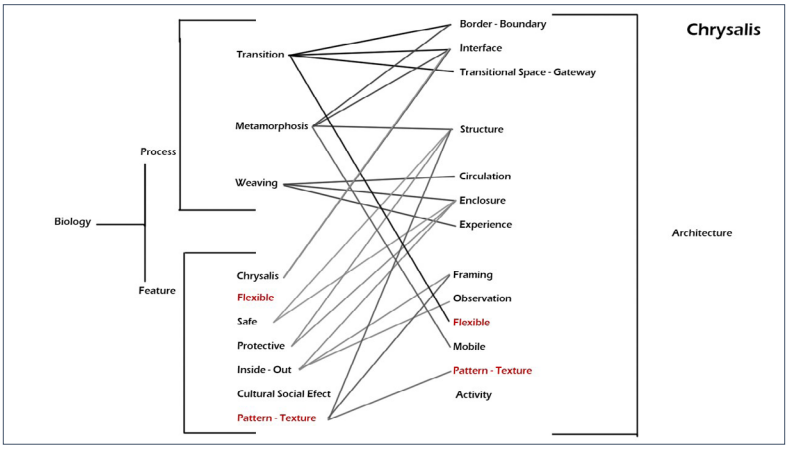
APPENDICES

	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]	Hibernation Time [Design Factory]	Wrap up [Design Factory]
11:15 - 11:30			
11:30 - 11:45	Knock Knock: Biology and Architecture [CompLab]		
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]	Hibernation Time [Design Factory]	The Final Showtime & The Curtain [DDS]
13:45 - 14:00	What is Your Cocoon in Architecture? [CompLab]		
14:00 - 14:15			
14:15 - 14:30	Ready - Set - Go [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	Showtime 1 & Reflections [Kubbealti]		
16:30 - 16:45		Transfer [Design Factory -> DDS]	
16:45 - 17:00			

Figure 41: Program of Cocoon workshop







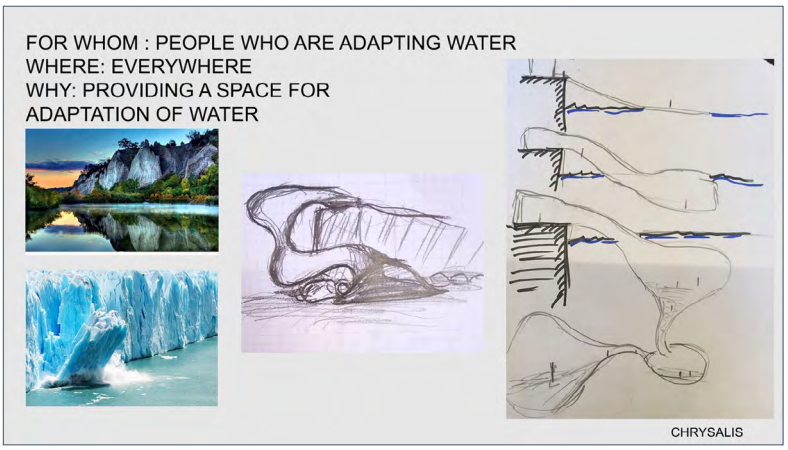
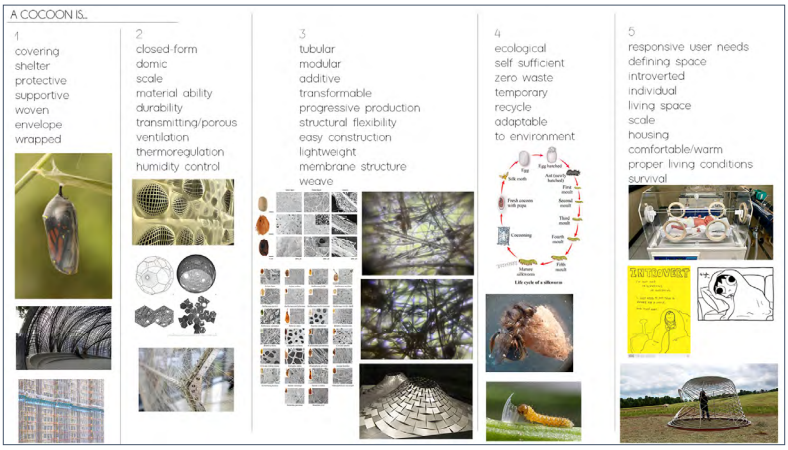
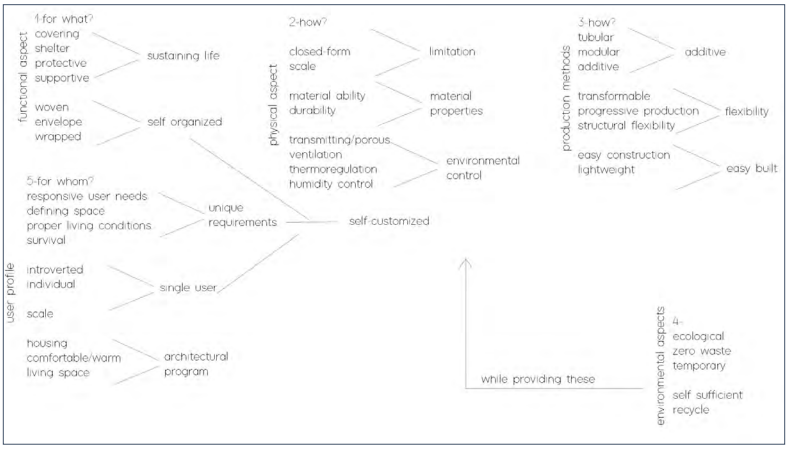


Figure 42: First day presentations of Chrysalis group at Cocoon Workshop





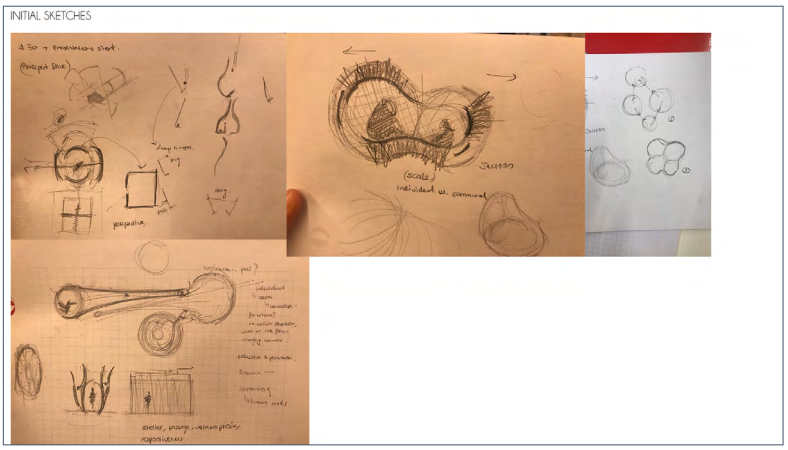
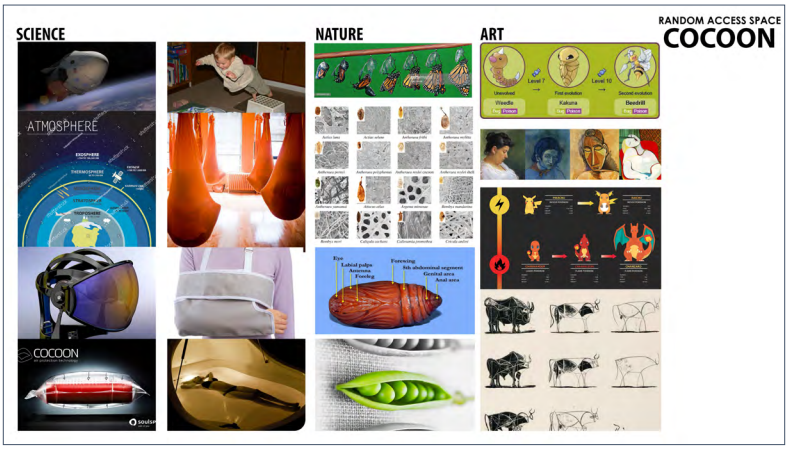
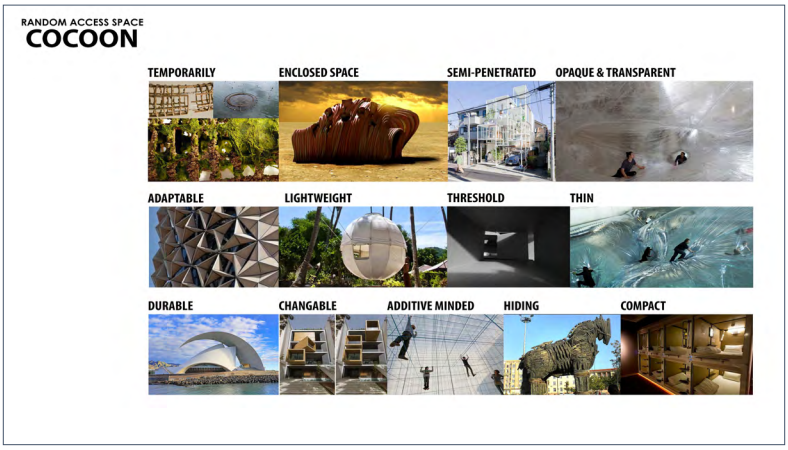
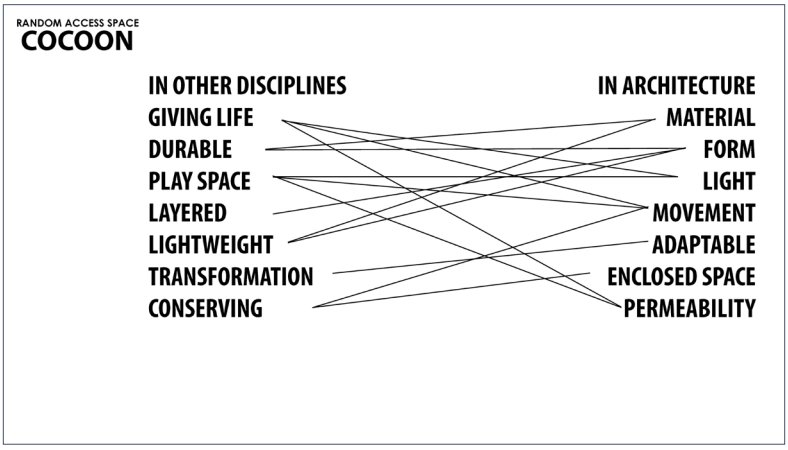


Figure 43: First day presentations of Continuum group at Cocoon Workshop







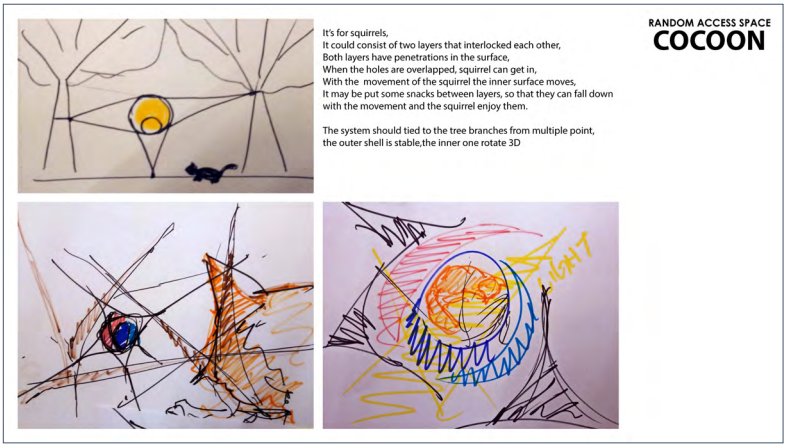


Figure 44: First day presentations of RAS group at Cocoon Workshop

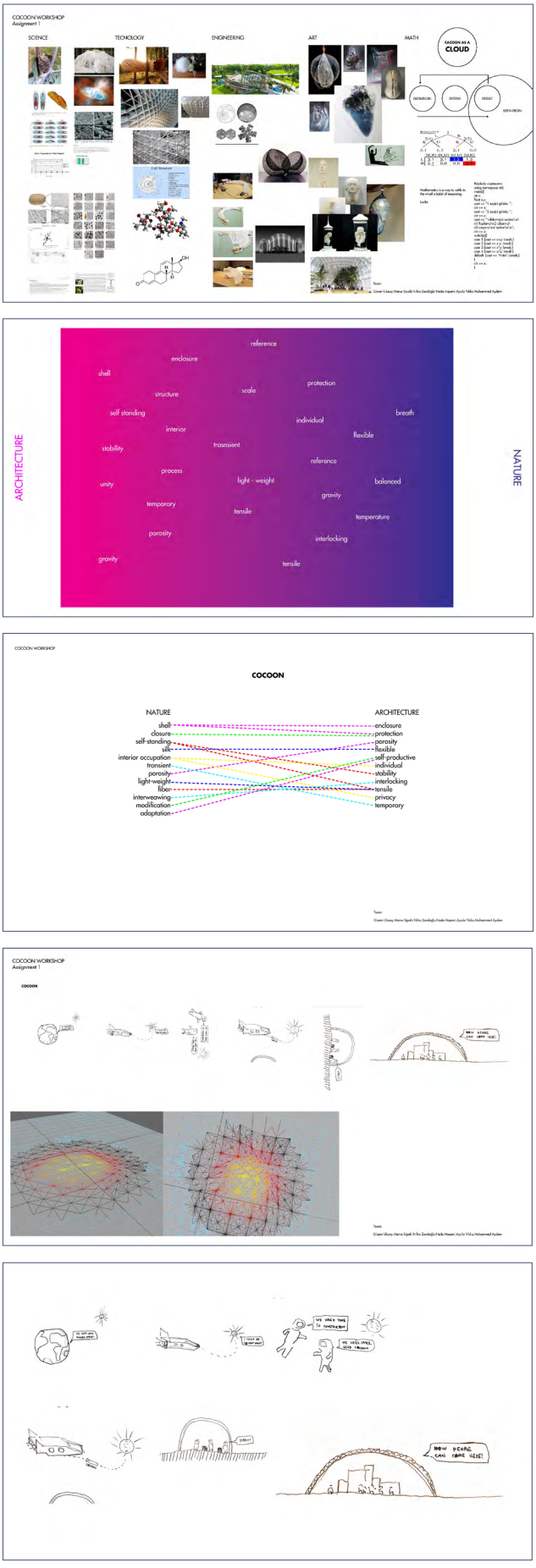


Figure 45: First day presentations of Re-Membred group at Cocoon Workshop

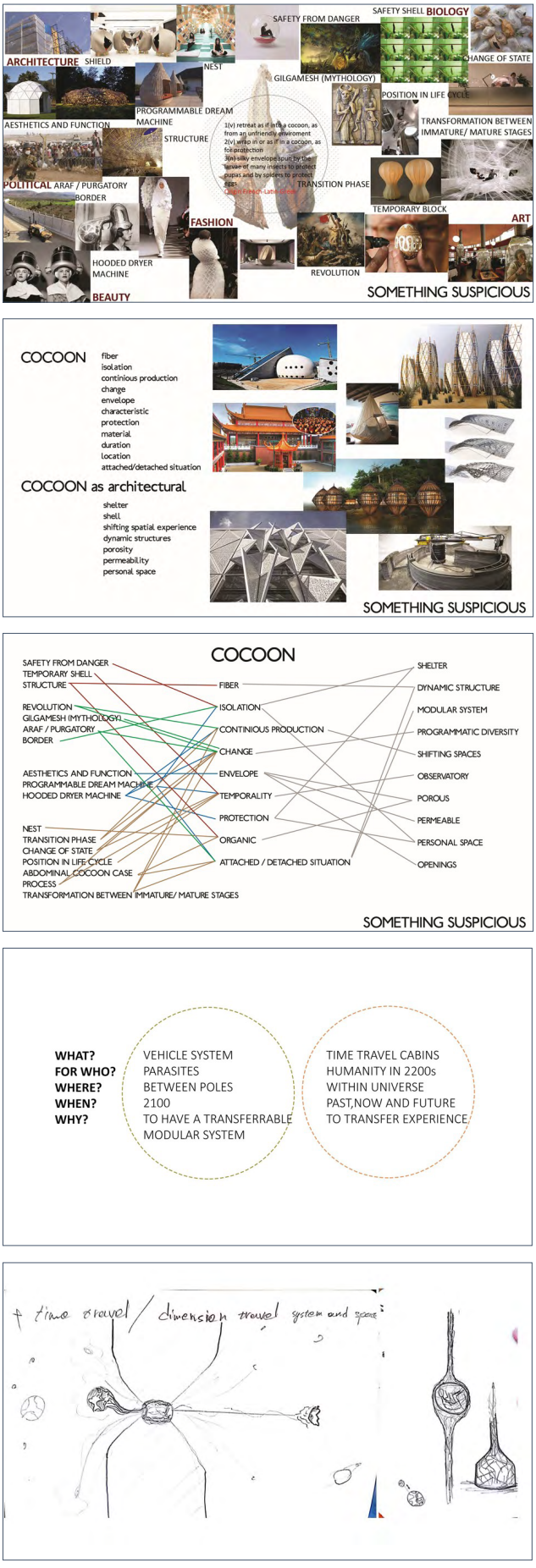


Figure 46: First day presentations of Something Suspicious group at Cocoon Workshop