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FABLABs – new technologies in adult education

Good practices from the European cooperation

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Introduction

We offer this publication as a journey through various theories and practices of adult learning based on a FabLab concept.

This journey was possible thanks to the Erasmus+ project titled “FABLABs – new technologies in adult education” (a Strategic Partnership in Adult Education), which brought together FabLabs and similar structures from various European countries

- Aalto Fablab | Finland
- Artefacts | France
- Buinho | Portugal
- Fab Lab Reykjavík | Iceland
- Robisz.to | Poland
- Workshops of Culture | Poland

The 34 months of challenging pandemic time allowed us to work together on a general topic of “FabLabs as adult learning environments”. The project took a closer look at various ways of organising learning and the principles of interaction with local communities to:

- recognise good practices in providing education on new technologies to adult learners using a FabLab concept of work
- exchange know-how in the field of teaching methodology (education methods and practices)
- investigate the way to apply a FabLab concept to adult education
- deepen the professional development of people working in FabLabs as educators and managers
- allow comparative research on teaching new technologies in non-formal education in various European countries.

The idea for the project was to gather FabLabs of different legal forms (as a part of a university, a cultural institution, a secondary school and a national network, a social cooperative and a non-governmental organisation). We sought to cover different European regions to have a good recognition of various approaches to FabLab work and adult education. The idea was to involve FabLabs operating in larger and smaller cities, as well as in rural areas, and also present different approaches to adult learning.

Each organisation in this consortium has a different background and approach to FabLab work. Also, their experiences in adult education are different. Moreover, the FabLab concept has different values and recognition in every country. Our project aimed to find out the similarities and differences between us and try to demonstrate the inspiring practices of FabLabs as a learning environment for adults. The varied experiences and conditions of the partners contributed to the process of mutual learning, exchange of ideas and good practices, and connectivity.

The project focused on adult education which can be defined as “all forms of non-vocational adult education, whether of a formal, non-formal or informal nature” (according to Erasmus+ Programme Guide[1]). In this concept, an adult learner is “any adult who, having completed or being no longer involved in initial education or training, returns to some forms of non-vocational continuing learning (formal, non-formal or informal)”[2]. We focused on FabLab users as we explored how they participate in the learning process of using new technologies. New technologies found in FabLabs give rise to this exploration and how spaces, technologies, and people interact to foster learning. We explored the topics of effective

[1] Erasmus+ Programme Guide 2022 (version 2), p.417.
[2] Ibid.

teaching methods that can be applied in FabLab work, the use of new technologies in adult education, and better recognition of adult learners' needs and expectations. For this, we have organised an exploratory survey to complement the work produced over the project scope. We have developed a common questionnaire form that was translated and distributed among our adult learners/FabLab users. The questionnaire is attached as an appendix to this publication, and the results are further explained in the text.

Additionally, we wanted to explore a unique FabLab model that promotes the transitivity of educators' and learners' roles (learners becoming teachers/mentors). And finally, we aimed to reach a better recognition of FabLabs as an adult learning environment.

The project's main activities were partner meetings in each country. This allowed us not only to work on the project results but also to deepen our knowledge of each institution, its educational practices and working conditions, and meet a number of local partners. The project contributed to the professional development of people working in FabLabs as managers and educators, strengthening their skills and competencies, widening horizons and allowing them to meet colleagues from all around Europe.

In the following pages, you will read more about the FabLab concept itself, how FabLabs can be perceived as a learning environment, and about each partner organisation that forms the project consortium and the good practices from their work.

For more information, please visit the project website: https://fablabserasmus.eu/

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Why FabLabs?

A FabLab is a laboratory with tools to create (almost) anything!

The term FabLab is an abbreviation of Fabrication Laboratory – a digital laboratory or workshop in which, thanks to computer-controlled devices (such as 3D printers, milling machines or laser engravers), you can transform your ideas into prototypes and finished products.

Officially, FabLabs are places that comply with The Fab Charter[3] and are part of the Fablab Network (participation in it requires, among others, the obligation to have specific equipment, facilitating the sharing of knowledge and exchange of people and projects). The Fab Charter defines FabLabs as "a global network of local labs, enabling invention by providing access to tools for digital fabrication. Fab labs are available as a community resource, offering open access for individuals and scheduled access for programs"[4].

The concept of FabLabs was born at one of the best American technological universities – MIT (Massachusetts Institute of Technology). The originator of this concept is Prof. Neil Gershenfeld, director of the Center for Bits and Atoms at MIT, who launched the "How to Make (almost) Anything" course at the university in 1998 and is now considered the originator of the first FabLab and an active promoter of this idea. Prof. Gershenfeld proposed a revolution in design and production: any university student could enrol in the course, regardless of the field of study. Therefore, the group consisted of people with different skills and competencies. The group worked in a well-equipped studio: they had computers, a laser cutter, a 3D printer, and a set of electronic components at their disposal. But it was their ideas that mattered the most; the tools were only there to serve its implementation. When the FabLab idea became a success, Neil Gershenfeld decided to test its effectiveness outside the MIT campus.

The idea was simple: to provide the right environment, skills, advanced materials and technologies to cheaply and quickly create things anywhere in the world and make such spaces available locally – for entrepreneurs, students, artists, small businesses, and in fact, for anyone who wanted to create something new. The objective was to stimulate innovation, creativity and entrepreneurship. However, there are also spaces with other names which fulfil similar functions – makerspaces, hackerspaces, production studios or medialabs. The concept of FabLabs is therefore firmly based on the idea of DIY (do-it-yourself), the maker movement, and hackerspaces.

FabLabs and makerspaces epitomising this phenomenon can go beyond their primary mission as spaces of experimentation and fabrication. Since their very beginnings, FabLabs have promised to strengthen bottom-up civic initiatives that promote invention. Such spaces also started to emerge outside urban settings, such as northern Norway, rural India and Ghana, as a strategy to enable community activation and tackle the digital divide. According to the Fab Foundation, there are currently 1750 registered FabLabs worldwide in more than 100 countries[5]. It is an open creative community of makers, artists, scientists, engineers, educators, students, amateurs, and professionals of all ages. From small community workshops to advanced research centres, FabLabs share the common goal of democratising access to technical innovation tools. Such creative spaces can help create a new sense of place in remote rural towns by blending local traditions with digital technologies, thus encouraging new users.

[3] Fab Charter, 2012. http://fab.cba.mit.edu/about/charter/

[4] Ibid.

[5] Fab Foundation, 2021, https://fabfoundation.org/. The Fab Foundation provides information about the registered FabLabs around the world and their different fields of action.

FabLab allows individuals and businesses to train their creativity and implement their ideas by designing, shaping, and producing objects with the help of digital technology. Therefore, FabLab forms a creative community of curious solution-focused makers at all levels of society.

Because the FabLab concept has grown so fast and can be applied in multiple ways, we found it to be an appropriate anchor for this project.

Additionally, during this shared journey, the project partners have enlarged the scope of this project to incorporate the perspective of the makerspace (as a result of the participation of the l'Atelier 216 in the project). Therefore, we find it essential to include a short description of what a "makerspace" is in this publication.

A makerspace is a place dedicated to creating objects using various "machine tools". It brings together, in one place, a large public, expert or novice, who comes to learn, train and use the machines which are at their disposal. It is a place for sharing knowledge, just like FabLabs, but it is exempted from following The Fab Charter.

Being a "maker" is, above all, a state of mind, halfway between the tradition of doing things yourself, inherited from the past. "Maker culture is a contemporary culture that is a branch of the do-it-yourself (DIY) culture that focuses on technology and group creation"[6].

Throughout this project, the partners were also brought to discover and learn about the "Third spaces"[7]. They are places and spaces between home (first place) and work (second place) with all the comforts of home and all the company facilities for working and physical spaces for doing things together. In Third spaces, people create, train, learn, do things together, make things, participate, create social links, etc. They are places for doing, levers of innovation thanks to the meetings, collaborations and collective projects they encourage, thanks to the learning and creativity they promote and thanks to the social spaces they offer.

We find it interesting to mention this since this term is very popular in France, and many FabLabs define themselves as the "Third spaces" (and are perceived as such by their users). This is not the same in other partners' countries, where spaces with similar characteristics are not labelled under this particular common denomination.

Makers of change

In the networked knowledge society that we live in, FabLabs are part of an array of creative spaces with multiple configurations and fulfilling similar functions such as makerspaces, hackerspaces, medialabs and food labs. Behind the idea of a FabLab is the promise of finding a space where we can make almost anything. A space where we can transform ideas into prototypes. A space where objects can be tinkered with, modified and fixed. A place where new materials can be tested and invented.

This concept developed at MIT has become one of the various physical representations of the maker movement worldwide. These spaces have gone beyond their primary mission as a space for invention, experimentation and fabrication in cities, where "hobbyists, engineers, artists, designers, hackers, and craftsmen are exploring new ways for personal expression by hacking and remaking their physical world as they see appropriate"[8].

[6] https://en.wikipedia.org/wiki/Maker_culture

[7] https://thirdspacenetwork.com/about/defining-the-third-space

[8] Rosa et al, 2017, *Overview of the Maker Movement in the European Union*, p.4.

This urban, community-driven movement has been a civic response to a technological consumer society. The maker movement advocates the empowerment of citizens as emancipated creators and not just as consumers, thus contributing to the DIY concept. FabLabs hold the potential to increasingly work on societal challenges and environmental sustainability, being able to impact mainstream production by focusing on the circular economy and distributed local manufacturing. These spaces have extended their initial academic purpose and entered multiple spheres directed at different target groups, such as adults.

FabLabs in over 100 countries have specialised in different domains, and we can find various layers of action and social dynamics. For example, the United Nations Migration has supported the FabLab of Djibouti city to support young migrants, refugees, and locals by providing training and assistance in digital fabrication technologies[9]. The FabLab Barcelona, the first FabLab with projects funded by the European Union, has been ground-breaking within citizen science and exploring future educational models[10]. The Smart Citizen Project aims to encourage communities to better understand their surrounding environment by collecting digital data on pollution, which is critical to inform governance and enhance active civic participation.

If we reflect upon the presence of FabLabs in Europe, we can encounter multiple FabLabs working on societal concerns. For example, some work with migrants, unemployed young adults and excluded minorities. In contrast, others focus on fostering the presence of women in science and technology and being open to the use of space by local communities. Some FabLabs work with elderly populations to mitigate the digital generational gap. In contrast, others carry out more interventive work on citizen science and in the training of elementary school's teaching staff. These are examples of the work developed by the different FabLabs across Europe under this partnership project.

[9] FabLab Djibouti, https://theresiliencecollective.org/index.php/fab-lab-djibouti/
[10] Barcelona Fablab – Smart Citizen Project, https://iaac.net/smart-citizen-project/

FabLab as a learning environment

This chapter aims to give an overview of the adult learning process in FabLabs and indicate what factors are important in shaping a learning-friendly environment in FabLabs. The chapter results from the collective work of the project partners who shared their expertise during a series of meetings. Despite being different in structure, size, or activities, the partners managed to identify areas that are crucial and common to most regarding FabLabs as adult education places.

FabLabs can be seen as platforms for learning and innovation: places to play, create, learn and invent. They work by offering access to shared infrastructure, digital production tools, and a community of practice. They are usually equipped with carpentry and electrical devices, 3D printers, computer-controlled machine tools (CNC), electronics (e.g. Arduino platforms and Raspberry Pi microcomputers), computers and programming tools supported by open source software. Their activities vary from textile crafts, electronics, and advanced robotics to traditional woodworking. FabLabs offer both participation in structured courses and the possibility of tinkering independently.

They provide open access to machines and tools, but also the knowledge and experience of other people. They enable innovations but also, for example, the repair of broken home appliances. Thus, they respond to the needs of people with different competencies, skills and material resources. The primary goal is to implement your ideas, develop a passion, and derive more joy from learning. Thanks to the concept of sharing, FabLabs are generally accessible and (usually) non-commercial places. Thus, they foster the fight against technological and digital exclusion; they also support grass-roots initiatives and the involvement and cooperation of local communities.

FabLabs should be seen as important actors in adult education (or in Life-wide learning in more general terms) – in both formal and non-formal education systems – as they promote an entrepreneurial drive and autonomous learning. FabLabs and makerspaces "can have a transformative and empowering role by grasping and nurturing individual capabilities for the benefit of the entire community"[11]. In adult education, these spaces can enhance the acquisition of essential digital competencies and become gathering spaces where, for example, DIY science is made. What specific FabLabs have in common is that knowledge in technology is seen as an opportunity for emancipation in our information age. They also explore the commonality of documenting and sharing information and projects through community networks to foster **peer-to-peer learning**.

While FabLabs focus on innovation, prototyping and production, they are primarily communities, supporting learning new skills and abilities based on individual interests, experience, self-expression and creativity. Using a **Make-to-learn approach**, they empower users to access previously unavailable tools and skills essential to succeed in the 21st-century economy. Thus, they raise the general level of technical education in societies. FabLab as an adult learning environment supports the development of key competencies, including mathematical and basic competencies in science and technology, digital competencies, learning to learn, a sense of initiative and entrepreneurship. These are environments of genuine cooperation and collaboration, focused on a democratic approach to education, emphasising learning through direct experience, joint projects, DIY and innovation. FabLab thus proposes a new model of teaching and learning that extends beyond the traditional education system's framework, integrating creative people's environments and creating local communities and learning environments.

There is no specific profile of a FabLab user or learner participating in FabLab activities – it can be anyone from the community. FabLabs' users differ very much – from students of technical universities who want to

[11] Rosa et al, 2017, p.8.

practice their subject in a more open environment, community activists who seek resolutions of specific community problems, to those who just want to work on their projects, share their skills and learn new ones. Generally, FabLabs learners are people with various skills and different backgrounds, so FabLabs' educational offer has to be as flexible as possible.

FabLabs are essential places for adult learning, as they provide a great deal of freedom of development for their audiences, who have very different needs and are driven by different motivations. Some adults want to fill the education gap they feel many years after leaving the education system. They want to venture out and try something new in a place that allows for exploration and experimentation. It is non-judgmental and ensures a relatively low entry threshold for those without prior experience using the machines, tools, or software. Some people are driven by the need for a change in their professional lives. They see a FabLab as a place to gain new practical skills and certifications and expand their professional horizons and network. The opportunity to learn independently and be independent in directing their learning path also attracts people with creative and innovative potential to the FabLab. Those creating the prototypes and looking for manufacturing solutions are also an audience for FabLab-type studios. What meets the needs of all these groups is the way of teaching and the conditions that FabLabs offer.

A place of mutual education

Although FabLabs may be equipped with state-of-the-art technology, machines are not their most important aspect. Technology is merely a tool to achieve a goal, which may differ for each learner. The plan may be an individual's desire to create a project or innovation. It can be a goal imposed by the educator in the class, focused on solving a real problem, e.g. pollution in cities (**problem-based learning**). The plan can also be the creation of an actual, simple prototype or product, culminating in the workshop work – e.g. the first ever 3D printing (**project-based learning**). Whether participating in a structured class or on an individual learning path, educators help clarify goals for learners. It is essential that the person feels satisfied with the results of their work – they don't have to be perfect. It is necessary to learn through practice, to make mistakes and go through failures, and to consolidate skills consistently.

It is worth mentioning that FabLab is a place of mutual education. In addition to structured classes taught by educators and a "staff-to-peer" relationship, an important part of the learning process is the so-called **peer-to-peer education**, which takes place informally at the learners' level. FabLab creates an environment for exchanging knowledge between people of different professions, specialisations, and generations. In such an environment, everyone becomes a learner and a teacher at the same time. This is an important aspect of creating a community around the FabLab – learners feel their influence on other individuals and establish personal and professional relationships, fostering creativity and the emergence of spontaneous projects and innovations.

Many FabLabs offer ways to join the community, such as voluntarily, on a subscription or internship basis, or as part of long-term learning projects. The long-term prospect of being in a creative community is also an aspect that stimulates learning and creative work. At FabLab, the general rule is: "stupid questions don't exist". When creating individual and group projects, FabLab staff provides consultation and support. It helps with problems with the use of machines or with design. However, encountering obstacles is an everyday part of the learning process – often, the learner's issues cannot be answered by themselves or by FabLab staff. This is why the peer-to-peer relationship is so crucial in this process. Other learners can influence the creation of a new prototype, service, or product – they make a joint effort towards a shared achievement.

However, it is important to remember that FabLabs are not an open playground where there are no restrictions to the development of creativity. Most labs provide structured courses and workshops/activities

that enable novices to get to work on their innovative ideas. Before a learner can pursue their learning path, they usually have to go through training in the use of particular machines and tools. The trainer verifies the skills and aims to make the person feel confident using the device. Such activity takes place at FabLabs on a regular basis. Some labs issue certificates of completion of special training or courses respected outside FabLabs, such as Fab Academy Certificates.

Learning methods in FabLabs

FabLabs are usually fans of alternative teaching methods and experiential learning that are based on **student-centered pedagogy**, which aims to develop adult learner autonomy and independence by putting responsibility for the learning path in the hands of learners. The learners choose not only what to learn but also how and why. When the topics of study are relevant to learners' interests and needs they find their learning process more meaningful, and therefore they actively engage in understanding, creating and reflecting. It makes the learner a co-creator in the teaching and learning process. This requires from the educators a respect and understanding of individual differences in learners' backgrounds, interests, abilities, and experiences.

In our FabLabs we often use **problem- and project-based learning** approaches. They favour **learning by doing**, that relies on simulations and experiential learning. FabLab users learn how to solve problems in context, test their own knowledge, and apply it to practical problems. Those methods include learning activities that are personally relevant to learners and that give learners increasing responsibility for the learning process, stimulating their critical thinking skills. They include peer learning and peer teaching as part of the instructional method.

Laboratory, workshop or studio work

Laboratory classes, such as FabLabs, are an essential part of teaching science and engineering. They give students hands-on experience in choosing and using equipment. They develop motor skills in using tools and creative media. They enable learners to test and prototype, and teach how to design and conduct experiments. As FabLabs are equipped in a great variety of equipment, machines and tools, they support experimentations, creativity and innovations.

Project-based learning

Project-based learning is a teaching method in which learners are presented with products to develop. They learn by actively engaging in personally meaningful projects that can be challenged by a real problem to resolve or a complex question to answer. By using their skills and competences learner create a product and present it to the relevant audience. In this way they not only develop the skills necessary to create something real, but also a set of soft and social skills. Project-based learning requires critical thinking, problem solving, collaboration, and various forms of communication.

Problem-based learning

Problem-based learning is sometimes perceived as a subset of project-based learning, but there is some distinction between both methods. While in project-based learning learners have to produce an artefact/object to demonstrate their mastery of content, in problem-based learning they have to present a solution to a clearly defined real-world problem. Another distinction is that in project-based learning the emphasis is put on the end product, on generating and prototyping solutions, while in problem-based learning the emphasis is rather on acquiring new knowledge, and the ultimate solution to the problem is less important.

Learning by Doing / Learning by Making

It is a pedagogical method based on the idea that you can learn something better and faster if you practice it / do it / make it. At the heart of making is the idea that all students are creators, and hands-on learning plays a key role in maker education. It is an effective and a powerful learning method once a learner has already gained some familiarity with the content, so the making approach does not overwhelm him/her.

The working methods described above are the ones used most frequently by project partners.

FabLabs' staff as educators

FabLab teams are usually comprised of individuals passionate about technology and innovation, as well as having deep knowledge in their respective fields. There are a variety of positions and tasks available in FabLabs and they include FabLab manager, administrative support, maintenance, communications, community building, and business development. At FabLabs, volunteers also play an important role.

We believe that the role of FabLab instructor / teacher / educator / tutor / facilitator / mentor is still unrecognized in FabLabs. These roles can be described by a variety of terms, demonstrating just how different their tasks are, depending on a specific FabLab and on a specific target group. Many FabLabs do not have any special positions dedicated to those tasks and the education is performed by technological experts that do not have pedagogical experience. This of course can influence learning processes.

In FabLabs educators play an important role. In student-centered pedagogy their role is to encourage learners to do more discovery learning and to learn from each other. In fact, in FabLabs users can be both teachers and learners, and learning often requires a shift in the role of the teacher from that of a person who gives information at the front of the classroom to a facilitator facilitating the learning process, where the learner is a co-creator. That requires including the learner in decisions about how and what they learn and how that learning is assessed. Moreover, educators should respect and accommodate individual differences in learners' backgrounds, interests, abilities, and experiences, as well as motivate learner involvement and participation.

It can be very challenging to combine technical expertise with student-centered pedagogy, especially when FabLab educators have to deal with a very diverse group of adult learners. The discussions between the project partners have also shown that it is a big challenge to match educational methods to the different needs of adults and to their different learning styles. In this regard, we have discussed several methods and their usefulness for our structures, including:

- individual tutoring versus group workshops
- learning based on specific tasks to be performed versus projects based on participants' creativity
- online versus classroom learning
- long-term educational programs versus single classes.

Because FabLabs are supposed to be open to everyone, regardless of age, skills or educational level, these issues are a big challenge for educators. In addition, the catalog of activities that can be undertaken in FabLab is very extensive (from prototyping innovative solutions and products to repairing broken home appliances), which makes it necessary for the staff to have a great deal of knowledge and flexibility.

According to our partnership there are several characteristics (strengths) that make a FabLab educator particularly valuable. In our opinion, a great FabLab educator is someone who:

- can recognize and accommodate different learning styles
- can provide a framework/a structure for learning without being overly directive
- can listen to and respect each learner's opinion and point of view
- encourages and facilitates learners' shared decision-making
- helps learners work through difficulties by asking open-ended questions
- helps learners arrive at conclusions or solutions that are satisfactory to them
- can boost learners creativity and motivation
- helps learners in designing, creating, experimenting, and exploring
- creates a creative, inspirational and safe environment for experiment
- creates learning programs that combine abstract thinking (design) and physical activity (actual production of a physical object)
- makes sure that learners understand the principles and the steps of the whole process, and not only "produce"
- makes the learning experience relevant to the real world with its current challenges and emerging questions
- supports social and community learning
- supports social integration and community building.

In the project's course there were also several challenges expressed by the FabLab educators, including:

- shortage of dedicated staff in FabLabs
- lack of dedicated professionals for technical and conceptual support
- lack of pedagogical skills that could help to offer actual training beyond the technical support (use of the machines)
- difficulties in attracting new users and bringing new people to use the FabLab
- struggle to engage the community
- overcoming learners' fear of high technology equipment, and fear of the unknown which often prevent adults from joining the FabLab.

After evaluating strengths and weaknesses of our FabLabs' educators, an important postulate emerged from our project:

> **There is a clear need to strengthen soft and didactic competences among FabLab staff and to create mechanisms (and use the existing ones) in the field of educational mobility of educators, both at the national and European level.**

We imagine this for example as professional development programs especially designed for adult educators in FabLabs, focused on developing their didactic competences, incorporating andragogy and adult learning approach. This should be followed up by creating a wide network of FabLab educators, both on national and international levels. As a result, teaching knowledge and experience between FabLab educators could be exchanged in a natural and effective manner. It will also allow educators to stay up-to-date on the ever-changing technology.

The Partnership | That’s who we are…

Although FabLabs worldwide differ in structure and operations, they have in common: giving people the space to be creative and learn outside the box. During the workshop sessions, the project partners unanimously agreed that what is most relevant to adult education in FabLabs is clarifying the learner's personal goal, being in a physical space that stimulates creativity, a sense of belonging to a creative community, and a sense of being in a non-judgmental environment. Once the learner's needs have been identified, it is vital to select the educational path accordingly.

FabLab work is based on learning by doing methodology and requires creativity, imagination, critical thinking, high motivation, taking the initiative and problem-solving skills. Based on general pedagogy and approach to making, FabLabs provide their users with resources, both human and technological, community expertise, and high- and low-tech tools. They are genuine communities of practice that support learning new skills and capabilities based on interest-driven learning through real-life experiences and self-expression.

FabLab concept is also a great way to develop a “learning to learn” attitude; it happens through project-based learning but also learning to work with others; it helps develop the ability to collaborate and solve problems. It finally empowers learners in decision-making, risk assessment and constructive management of feelings.

FabLabs are a strong community-based network of learners and a peer-based, cross-disciplinary network of educators, where the division between learner and teacher is often blurred. In this case, it is more supported self-study than a knowledge transfer. This collaborative education helps people develop identities as lifelong learners and producers. Having a strong belief in these methods, we took it to heart. We made a conscious effort to dedicate each project meeting to identifying our different values and aiming to find out the similarities and differences between us and trying to demonstrate the inspiring practices of FabLabs as a learning environment for adults. The varied experiences contributed to the process of mutual learning, exchange of ideas and good practices. The following text identifies some of them and describes each project partner in more detail to give a clearer view of who we are and what we do.

Workshops of Culture | Lublin, Poland | project coordinator

WARSZTATY KULTURY

Workshops of Culture is a municipal cultural institution in Lublin, Poland. Our program focuses on promoting the practice of “active culture”. We create a culture that is modern, interactive, interdisciplinary and innovative. We work with artists and institutions from Poland and abroad and have developed highly efficient cultural education, management and animation methods. Everyday application of modern technologies in cultural education and the promotion of cultural heritage also form the core of our mission. We produce Lublin’s four largest festivals: Night of Culture, East of Culture – Different Sounds, Carnaval

Sztukmistrzów and Re:tradition. They are rooted in Lublin's history and traditions, have become an integral part of the city's cultural landscape and activate the local community.

In addition to the summer festivals, our major long-term projects include:

- Culture Volunteer – an educational programme aimed at creating a network of volunteers committed to the development of Lublin and regular cooperation with cultural institutions, non-governmental organisations, and artists
- Culture Incubator – an educational programme and innovative, creative lab established to improve the skills of employees and volunteers in the cultural sector in terms of management and creation of socio-cultural projects
- Master Classes – an educational programme focusing on selected aspects of traditional culture and aimed at passing on material and spiritual knowledge and skills through classes with experts in traditional culture
- Patterns of Europe – a cycle of unique workshops, meetings and film screenings closely related to modern design
- Medialab Workshop – a space for the meeting of art, technology and new media, based on the FabLab concept, and a place for people interested in new technologies and learning how to use them.

Medialab Workshop enables people with different skills to learn and work together on new media and technology projects. Representatives of various professions, such as artists, designers, programmers, cultural animators, and academic researchers, share experiences and knowledge as they work on projects syncing media and technology. The projects combine different techniques, like audio and video with performance, to create synergies between each element – and multiply their impact.

Workshops of Culture initiated medialab activities in 2015 when we organised the Medialab Lublin Battle to boost civic knowledge and skills through new technologies. The event also aimed to improve digital technology skills and strengthen cultural institutions' role in building cultural cooperation along the Polish-Ukrainian border. Medialab Lublin Battle was followed by two editions of Youth Medialab Battle – a series of free workshops for students from Lublin's middle and high schools. The participants had the opportunity to experiment with high-tech equipment, learn about multimedia, and develop their own "medialab" projects related to Lublin.

In 2017, we reorganised our medialab activities and created a new Medialab Workshop. The workshop is both a physical space with high-tech equipment (such as 3D printers, CNC milling machines, various electronic devices, and sound equipment) and the name of a series of classes open to the public. So far, we have organised over 50 workshops for adult learners – citizens from Lublin and the region interested in new technologies. All medialab courses are led by experienced trainers and cover topics such as 3D printing, CNC milling, drones, video editing, field recording, sound design and digital storytelling. We also run a media volunteer program. Most of our workshops are free and open to all interested adult learners. No prior experience with new technologies is required. All classes consist of theoretical and practical parts.

In this way, we try to apply the FabLab approach in our work, even though we are not officially registered as a FabLab. We also cooperate with various FabLabs and makerspaces in Poland and provide opportunities for exchanging ideas and best practices.

For more information, visit https://warsztatykultury.pl/.
Follow us on Facebook @WarsztatyKultury and Instagram @warsztatykultury
Project contact person: Ewa Orzeszko, e.orzeszko@warsztatykultury.pl

Aalto Fablab | Espoo, Finland

Aalto Fablab is the digital fabrication laboratory of Aalto University. It is based on the classic MIT FabLab concept, has all the machines listed in the 100K FabLab specification, has open days and hosts Fab Academy, thus being an active node in the global FabLab network.

It is not just the machines but the knowledge around them. From idea to CAD and CAM design to fabrication with one or all the appliances, electronics, programming and system integration — that is what one is expected to get out of it.

Lab is generally open to the students of Aalto University but provides space and machine time to everyone else during open days. Membership options are also available. Anyone: a designer, a developer, an artist or a pensioner can apply for membership. Students, members and staff can book the machines through the web-based takeout.aalto.fi service. The open days are available for free to everyone.

Aalto Fablab is a place where you can make (almost) anything. You can learn and use each machine or fabrication method individually; combine your ideas with CAD/CAM skills and use a different machine for every part of your project that requires it. You can learn all the skills individually or by joining the Fab Academy. Aalto students, staff, and FabLab partners can see when the equipment is available and book it directly from the service through a specific booking system. The service includes instructions and user manuals too. The laser cutter is the most popular machine in the FabLab.

Fab Academy is a hands-on rapid prototyping course. Participants learn a complete set of valuable skills enabling them to create high-quality proof-of-concept prototypes. At the core of the Fab Academy is the idea that art, design, and engineering should not be separate fields. Instead, students are encouraged to learn a broad range of skills to accomplish complex goals independently.

It is a unique learning experience with live online lectures and connects hundreds of students worldwide from Boston, in the USA, to Kamakura, in Japan. Aalto Fablab is one of the FabLab nodes that can organise Fab Academy courses.

Aalto Fablab and the set design workshops do work closely together. They are organised in the same unit of Aalto Studios. The wood, metal and costume design workshops offer knowledge, tools, and space for making prototypes that need welding, wood machining or sewing.

Aalto Fablab will move to a new location after 2024. In the new layout, the integration of the FabLab and the other workshops has been improved so that they can operate together better. A new green lab for growing bio-materials will be established because of the need to find new materials that replace plastics and other fossil-based substances. The green lab will be suitable for growing mycelium, algae and fungus that do not require biosafety classification.

Great emphasis has been put on the development of education in the FabLab that mixes university students, entrepreneurs, designers and other life-wide learners. One of our efforts has been to implement Fab Academy in the university's curriculum to offer the same information to both academic students and adult life-wide learners.

For more information, visit https://fablab.aalto.fi/.
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Artefacts | Orléans/Tours, France

Artefacts is a cultural cooperative of activity and employment (CAE) and represents a new approach to supporting the creation of new economic activities. The structure was created in November 2010 in Orléans (France, Region Centre), and it operates as a shared enterprise (scoop – société coopérative et participative), which means that its employees and cooperators (the entrepreneurs affiliated) hold the power of decision. Artefacts is classified as an enterprise of social and solidarity economy by its fundamental values and objectives.

Artefacts welcomes and supports entrepreneurs whose projects fall under the sector of creative industries – artists, artisans, designers, professionals in digital data, researchers, trainers and educators. They profit from the collective force by developing various projects together. Professional activities of the Artefacts' entrepreneurs cover various complementary fields and make the cooperative a national stakeholder with transversal (cross-disciplinary) expertise.

The headquarters of the cooperative is located in Orléans and Tours. There is also a facility in Blois and employees in Nantes, Paris and Strasbourg. Altogether, Artefacts provides various working spaces, methodological support, training, guidance, and financial and technical resources.

As of today, Artefacts consists of 6 members of support staff, 42 full-time co-operators and 73 employees benefiting from an ESA contract (status of an associated entrepreneur-employee is a new form of working contract characteristic for French cooperatives).

Artefacts is dedicated to art and culture in its broad sense. The activities of the cooperative are the results of all the particular projects of its members, as well as their joint effort in the strategic line of development of the cooperative.

Artefacts teams up with various partners throughout the Region Centre and in France. The structure's national network comprises associations, small businesses, large groups, research laboratories and public communities. These collaborations allow us to produce effects at different scales and to reach a wide range of the public.

Pôle Maker is a competencies cluster operating within Artefacts. It regroups entrepreneurs who define themselves as “makers” whose professional occupations are mainly dedicated to “physical creations”: woodworking, handcrafting, scale models, sculptures, etc. However, unlike the digital approach, the makers’ productions often combine the best from the two worlds and source from the richness of the FabLab.

Makerspace “L’Atelier 216” is an “extension” of Artefacts. Founded and run by two Artefacts’ entrepreneurs, this association is dedicated to developing DIY, handcraft and woodwork accessible to the broad public. Its main objective is to support the emancipation of those who want to create objects and solutions using their hands and their manual skills (and potential). It offers a secure working space, tools, guidance and learning programme to empower and enable to “make”.

For more information, visit https://www.artefacts.coop/ and https://www.atelier216.fr.
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Fab Lab Reykjavík | Reykjavík, Iceland

Fab Lab Reykjavík opened in 2014 and is the creative hub for Reykjavík, where innovators, makers, artists, and students share a space to create a better future. Fab Lab Reykjavík is the largest FabLab in Iceland, steaming with life and receiving 8500 visits per year. Fab Lab Reykjavík is a fully equipped digital fabrication FabLab based on the classic MIT FabLab concept, but most importantly, full of creative people. Fab Lab Reykjavík is open 45 hours a week, has five employees and is generally available to the public on all weekdays.

Our mission is to empower people to tackle societal and environmental problems through invention. Here we educate people to become independent makers, enabling them to use their creativity to invent and for a sustainable future. We realise our mission by upholding three areas of activity:

- **Innovation**; by providing space, digital fabrication tools and support for prototyping inventions.
- **Community**; building the maker community and connecting to other creative sectors in Iceland.
- **Education**; supporting 21-century education with a focus on creativity and technology.

Fab Lab Reykjavík has launched several educational projects in the field of innovation and is a powerful partner in various innovation projects. There are nine FabLabs around Iceland, which are highly cooperative through the Fab Lab Iceland community. They all operate to increase knowledge of digital manufacturing methods and promote innovation. FabLabs in Iceland are platforms for innovation,

empowering inventors from various channels to prototype their ideas. In 2021, the Icelandic government strengthened the operating basis of Fab Lab Reykjavík with the Ministry of Industry and Innovation's involvement and the Ministry of Education and Culture. Þórdís Kolbrún R. Gylfadóttir, the then Minister of Innovation, formed a clear role for Icelandic FabLabs in the Innovation Policy for Iceland. The policy was followed up with a framework for FabLabs in Iceland. The operational aims are to elevate the creativity of citizens, support the development of innovative ideas and enhance technical literacy.

Fab Lab Reykjavík is an open community lab with a full-scale research lab capacity. Our users are all persons over 16 interested in digital fabrication: students, engineers, artists, tinkerers, teachers, designers, entrepreneurs, researchers and curious citizens. The lab is open every weekday, with one or two persons supporting makers in their fabrication. During the week, various courses, events, and training are also taught. We can only support all our makers by facilitating independent work in the lab. The shared inventory of FabLabs is the first step to achieving this, the tools chosen are powerful digital fabrication tools, but more importantly, they are user-friendly, so people can often use them on their first visit. The shared inventory also ensures that when a person is familiar with one FabLab, they can easily use any of the 2000 FabLabs around the world. FabLabs encompass a massive community of makers that build a shared knowledge base on digital fabrication; this is the magic ingredient that ignites a FabLab.

Entrepreneurs have access to Fab Lab Reykjavík to prototype their ideas, which is increasingly important in developing green innovations that require hardware to tackle thorny scientific problems. Makers are the constant gardeners of our community. Curious and eager to understand new technologies, they pioneer when implementing new methods in the lab. They play with technologies just for the joy of it before there is any clear purpose for using the tech. Co-creation and a playful attitude toward new technologies anchors knowledge around physical machines. Cooperation for invention and curiosity about new technologies enable FabLabs to be cutting-edge spaces for innovation.

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Robisz.to | Warsaw, Poland

The association Robisz.to was founded in September 2016. The name itself refers directly to the worldwide maker movement (Polish "robisz" means "you make, create or produce"). Our mission is to promote non-formal and informal education in areas related to creating, to introduce STEAM ideology to schools, and to spread the idea of the maker movement and the idea of open technology, according to which everyone should have access to tools that enable learning and creating. Our first activity was to create a space where we could carry out our mission – a place for our work and a studio open to other creators, artisans, entrepreneurs, and people looking for development opportunities, fulfilling an integrative function for the community. Half a year after starting our activity, we established a centre for developing open technologies, open source design and open hardware – a FabLab. The lab was opened in Warsaw in June 2017 under the name FabLab powered by Orange.

A laboratory is a crucial place where our mission and other statutory goals are realised. We distinguish them in three areas of activity: 1) education, 2) making in the field of digital fabrication and craftsmanship, and 3) community building.

Education, as the first core of our activity, is based on conducting projects and specialised workshops in the field of digital fabrication and craftsmanship. We show that non-formal education can be competitive and carried out at the highest substantive and didactic level, opening development opportunities, sometimes greater than traditional education. By addressing social and educational projects to groups at risk of exclusion, we realise our statutory goal of preventing and counteracting pathologies and social exclusion. The target groups vary depending on the nature of the educational activities. Free of charge activities in the framework of social projects are directed:

- for projects equalising opportunities – to people from environments threatened with social exclusion, with fewer opportunities for development, in a difficult life and material situation,

- for projects supporting entrepreneurship – to people who want to expand their competencies, are enterprising, looking for help in implementing start-up ideas from the technological side, developing hardware projects,

- for projects raising awareness of creation and building community – to families with children, open groups, amateurs and DIY hobbyists.

The second area of activity, or “making”, refers to our statutory objectives of initiating and supporting innovative activities in the field of new technologies, promoting innovative technological solutions in cooperation with the business sector, and taking action to create, search, test, implement and promote solutions to help local communities achieve self-sufficiency, in all possible aspects. We carry out these activities mainly through the execution of professional technology assignments. They are the primary source of income in our business activities, which support our statutory activities. The area of this activity also includes fulfilling our statutory mission of developing the DIY movement in Poland and scaling the FabLabs project to other cities. Our studio has become the central and most active FabLab in Poland, inspiring other cities and communities to take up the movement for creating similar centres in their environments. As an association, we actively participate in creating such labs in our country. We have designed several new studios on behalf of entities: FabLab Małopolska for the Małopolska Regional Development Agency, FabLab at ZS No. 1 in Warsaw, FabLab at the Józef Piłsudski Museum in Sulejówek, FabLab for the “Praga'” House of Culture. We also consulted on establishing more than a dozen new labs in the country, such as FabLab Gdańsk. By the end of 2022, the association will open two new facilities in Wroclaw and Olsztyn, which will become STEAM education centres. Two mobile labs will also be launched, enabling new technology education to reach rural groups.

The third activity area – community building – fulfils our mission and statutory goals of animating, integrating and activating society and shaping attitudes of active participation in culture and social life.

For more information, visit https://robisz.to/.
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Buinho | Messejana, Portugal

Buinho Association was created in December 2015 as a rural FabLab (Digital Fabrication Laboratory) focusing on conducting and disseminating digital education, citizen science and circular-economy activities in one of the most isolated areas of continental Portugal. Buinho Association is located in the village of Messejana (800 habitants), in the socially and economically depressed region of Baixo Alentejo. Yet in just five years of its activity, Buinho became a reference point in the European Maker Movement due to its innovative nature in rural areas and creating of a network of makerspaces within the village. The name Buinho refers to the material and technique of the Alentejo region's local tradition of chair weaving. Although we are a technologically-based project, it has always been our focus that our core values were based on respect for local values, traditions and heritage to give meaning to it.

We have a mission of tackling the digital gap between rural and urban areas by providing training and education to local communities. We are developers of educational content in digital manufacturing and STEAM specifically targeted to local contexts such as climate change and heritage preservation. Besides education, Buinho rapidly became a regional creative centre mainly due to the success of its international artists in the residency program. Within the FabLab and maker movement context in Europe, we firmly commit to environmental sustainability and social innovation in rural areas.

What brings difference to our adult education approach is its intergenerational intertwining. We started our initial work with children and young people, but soon these target groups brought their families and school teachers to the play. Furthermore, since we are in a region where its biggest societal challenge is the growing elderly population and early school leaving of young adults, we have focused on our local community activities on digital capacitation through electronic repair initiatives and in the foundation of a local precious plastic recycling centre. Our international artistic residencies program has also been essential in creating ties and engaging greater participation of local adults and youngsters in Buinho activities, some focusing on women's involvement in maker activities. From 2015 to 2022, our impact has extended to the village of Messejana, and we have expanded our adult education programme to a regional level. Our target groups within the adult population are young adults who don't study or work, the senior population, parents of local children engaged in our activities, and school teachers.

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Sharing good practices | Case studies

This chapter presents case studies collected from the project partners' practices. Making a selection from all the good practices the project partners could share was very challenging. In addition, as the partners exchanged practices throughout the project, they noticed similarities between their projects and activities (e.g. providing protective face shields to communities during times of pandemic). Hence, this chapter presents examples illustrating various approaches and activities, from how the lab is organised to ideas for specific projects and activities.

Fab Lab Reykjavík | A MakeBreak

The mission of Fab Lab Reykjavík is to empower people to tackle societal and environmental problems through invention. Here we educate people to become independent makers, enabling them to use their creativity to invent for a sustainable future. A colossal endeavour that only gets more complicated in practice. Therefore the space in Fab Lab Reykjavík needs to work for every user, regardless of background. FabLabs are places where you can make (almost) anything. The "almost" does not refer to the lab's capacity but that developing harmful inventions, such as weapons, is forbidden. People have different skills and interests, with various methods of materialising and communicating ideas. A FabLab should be a place where people can prototype beneficial ideas and develop skills for innovation.

In essence, having the tools required and an accessible maker in the lab supporting newcomers and building a community is a key to a successful lab. Most FabLabs have dedicated open hours/days to achieve this. In Reykjavík, they are once a week for seven hours with 2-3 dedicated instructors in the lab. The open hours are the most exciting time of the week when a vibrant community of makers has free access to work on their projects. On other weekdays the lab is open 9 hours a day while employees work on other projects such as teaching, maintenance, or desk duties. But even though the lab was open on weekdays, the makers rarely visited, so the lab lost the lively playfulness of the open hours. A question emerged: Why didn't makers use the open lab outside the dedicated open hours? Was it perhaps because they felt they were interrupting the daily workings of the lab? Makers seemed more comfortable with "interrupting" us while we were working on hands-on tasks. After observations, we noted that makers were usually drawn to the things we were working on, so leaving the task was seldom necessary. However, people don't want to interrupt us if we hide behind our computers and feel even more uncomfortable if we leave our desks or worse, leave the meeting! Then we thought it might be a good idea to hang around close by, ready to provide support, so the user would not need to interrupt us again. As you can imagine, this made our users feel like children that needed monitoring, which was not our aim.

How could we change this? The solution was implementing a MakeBreak for the FabLab employees. A MakeBreak is not a break; the person on the MakeBreak prioritises welcoming and supporting users during this time while working on hands-on tasks. During the MakeBreak, employees don't attend to their day-to-day desk duties, ensuring the constant presence of a Maker in the lab. If no users are in the lab, we work on projects that remove us from our desks and require making. This would, for example, be a time when we make needed items for the lab and learn through making. Who doesn't love a MakeBreak from mundane e-mail checking?

As we implemented the MakeBreak, we expected more visitors. Still, we believed that as users became more independent, they could support each other more, freeing up some time for employees. This would reduce the need for our MakeBreak, seeing that more independent users would give us even more learning time or ability to return to our desk duties. As expected, the employees MakeBreak increased the number of FabLab users over the week; visitors more than doubled. However, their projects rapidly got more complex, with four times more prototypes developed in the lab. We realised that independent users

don’t save time for more work; their questions are harder to solve. Even so, learning happened through the development of prototypes.

The MakeBreak is a great success story for the lab; it has truly changed the dynamic of the Fab Lab Reykjavík with quantifiable results. It does require planning and defining tasks that can be paused if users need support. Dedicated open hours are still on schedule, and makers are drawn to this time like before because they can expect to meet other makers and get help from employees with difficult questions. Open hours are also the most popular time for first-time visitors. The MakeBreak ensures that the lab remains lively throughout the week with a spur of activity during open hours.

In the end, the most important thing was to have a predetermined employee responsible for greeting and supporting users. Importantly, we only use collaborative tools and leave our laptops at our desks; instead, we use the available FabLab computers. When we are on a MakeBreak, there are almost always users in the lab, but if there aren’t, we start making.

Artefacts | Introduction to the makerspace and safety measures in l’Atelier 216

The teaching/learning approach in the makerspace called l’Atelier 216 is based on the logic of “train the future trainer” and is very much influenced by the safety measures that apply in places with sharp and hazardous working tools. The more experienced makers of the l’Atelier 216 train the newcomers in “professional gestures” before allowing them to use the electric machines and other devices. Then, with time, the trainees become the trainers to the up-coming makers.

Currently, l’Atelier 216 has six experienced professionals who lead the sessions of introduction/adaptation (called “visite libre” – free visit). Depending on the experience of the aspiring members, there need to be at least two sessions before they can become fully-fledged users of the makerspace (and, in some cases, autonomous users).

This procedure is stated in the internal regulations of the association that holds the makerspace. This was the condition sine qua non for the l’Atelier 216 to exist as a learning venue continuously opened for new members.

Aalto Fablab | Machine Training Sessions and Expert Students

In the 12 years of running the Aalto Fablab, the lab has constantly been growing and expanding its available machine resources. Nowadays, the lab is equipped with a sophisticated collection of digital fabrication machines that range from a basic vinyl cutter to much more complicated CNC machines, laser cutters and terrestrial 3D scanners.

The way we offer machine introductions and support the usage of machines has also changed in recent years. Digital manufacturing machines have become increasingly user-friendly and less sensitive to minor user errors. Most of them can be considered non-dangerous for a trained user to be used independently, even without the highest level of mastery.

Machine safety introduction courses are organised for each machine at the lab at least once a month. In these introduction sessions, the student can explore how the machine works and understand the safety and design considerations essential to a successful operation. We have tried to organise most of these sessions at the time of the day considered to be much more suitable for most of our users, which is, after office and class hours, starting at 16:00 and onwards.

We have established a training session booking page[12] where users can choose from our various training courses. After completing the sessions, the users are rewarded with a machine booking permit. The permissions allow users to book the machines they are trained for via our machine booking service TakeOut and use the equipment independently. The training sessions were popular and helped us free up time that used to be spent booking machines via e-mail communications and training every user individually.

One of the most exciting parts of this pilot is that the sessions are organised and delivered by our expert students trained during Aalto Fablab in-house courses such as the Fab Academy and its academic overlay Digital Fabrication (parts 1, 2, 3 and Studio). The classes are a challenge for the students. There is a reward, not just academic credits, but opportunities to get employed by Aalto Fablab as student assistants and expert support staff in case of special events. This enables Aalto Fablab to organise sophisticated workshops with 20 participants or more. Available expert staff increases the possibility of a successful workshop outcome.

The new students must join the available advanced digital fabrication courses as they will stay in the university ecosystem and contribute. Fab Academy and its academic overlay is happening in the second (spring) semester, from mid-January to mid-June. It is best if students join the courses in their first year, after the introductory autumn semester. FabLab staff can cherry-pick the best students and offer them helper positions at the end of June every year when most of the university is about to leave for summer vacation. This way, student helpers are already available when everybody returns from their vacation in mid-August.

As our lab is currently run by two full-time personnel, the staff can sometimes be too busy to provide adequate support and in-depth advice to users. As time is a valuable resource, providing state-of-the-art equipment without enough consultation time is considered a time loss from where we want to be. To tackle this issue, we in Aalto Fablab also have our personal bookable in the booking system if a user would like to have a one-to-one project consultation session where we map out the different steps and needs of the project. During the session, the user describes a problem/challenge, and FabLab staff helps to choose the optimal path to proceed with the project.

Fab Lab Reykjavík | Supporting new Makers

Through the years, it has become increasingly clear that learners can be intimidated by the digital fabrication processes we teach. Tools for digital fabrication are becoming increasingly user-friendly but are still complex for a novice. For some, even the task of entering a lab can be daunting. It is hard to be a novice with big dreams in a fully equipped FabLab shared by “experts”. As prototyping inventions started taking up more time, we worried that this would leave newcomers unsupported.

The simple act of using technology for the first time is a different experience for the maker and a novice. Therefore we defined the skills needed to start experimenting and learning independently in a FabLab. We found that the threshold for independent making is surprisingly low. The users don’t need to be able to design complex prototypes; they just need to be able to create a file and safely use the machines. They usually cross this threshold after using a machine one to three times, depending on the device and their previous knowledge. After that, users start working on their ideas, asking the complicated questions we like to solve.

The ability to make and use machines is procedural knowledge, just as learning how to ride a bike or play the flute. Unlike declarative knowledge, facts you can know in a book, procedural knowledge can only be

[12] Aalto FabLab booking page: shorturl.at/px479

learned by doing[13]. Reading about bikes, balance and pedalling might spark an interest in bikes but will not teach anyone how to ride a bike. The same is true for prototyping, so the only way to learn to prototype and use a FabLab is by making something. However, the instructions designed by makers for makers, found in our lab, Youtube, GitHub and the like, did nothing to get newcomers to make.

So we analysed the needs of newcomers and found that they encountered similar problems on their first visits. The critical moment was starting their first project or making their first thing. Unlike independent makers and inventors who need support with *how to* create, new users would also need assistance with *what* to make. If people don't know what they can do, want to make or are not ready to tell us, it would completely stagnate their learning process. We would therefore need to come up with suggestions for them; this realisation sparked the development of starter projects for each machine.

The starter projects developed into the book *Creative Community* (*ice*. Skapandi samfélag). *Machine cutting recipes – Handbook of things*[14]. The design requirements for the instructions were complex; firstly, the book needed to change the behaviour of first-time visitors, from only looking at the lab to making in the lab. We hoped that the instructions would improve independent work in the lab. We also wanted the instructions to work with users with some experience and first-time users. Lastly, the instructions were supposed to improve learning so that users would not need to rely on the instructions.

We selected a starter project for each machine to get our users to make something on their first visit. We broke each project into principal tasks and then explained each task procedurally. Procedural instructions were selected because they only work when the reader takes action. Following the instructions, the reader could make objects on their first visit and learn new methods. Instructions like this work well for novices but can be incredibly dull for a more experienced user. People read instructions differently as their knowledge increases[15], so for the instructions to work for both beginners and return users needed careful planning. Here each principal task is identified with a name and a larger font. While newbies go through the book step by step, return users skim the instructions and find the task or action they are struggling with. Makers rarely make the object described in the book, deviating more and more from the book as their skills improve.

The instructions have met design requirements for first-time users, most often making something on their first visit. People feel more independent in the lab as they don't need to ask "silly" questions; instead, they just have a sneak peek at the book. With time they don't need the instructions anymore but may use them again if they have not visited for a while.

The book is used in many makerspaces around Iceland and Europe and has been quite a hit. It is freely available online, but users often prefer the printed version. One unexpected benefit came from elementary schools, with makerspaces using the book. Teachers discovered that kids who were generally uninterested in reading did find reading the creative community book interesting when working in their makerspace. It seems that using procedural instructions sparked an incentive to read. Of course, this "reading for making" observation would need to be explored with proper research. Until then, we are just happy that our instructions work.

You can find the handbook here: https://www.flr.is/kennsluefni?lang=en

[13] Norman, 2013. *The design of everyday things.* https://a.co/i4SKk8V

[14] *Skapandi námssamfélag machine cutting recipes - Handbook* https://www.flr.is/kennsluefni

[15] Eiriksdottir, 2011. *Procedural instructions, principles, and examples: How to structure instructions for procedural tasks to enhance performance, learning, and transfer.*

Buinho | Precious Plastic Community Centre of Messejana

Buinho has been developing environmental protection, sustainability and circular economy activities that raise awareness of these issues and empower the local communities to intervene in environmental issues that affect them. In 2018, Buinho coordinated an Erasmus+ youth project about the Precious Plastic that began this journey. The project enabled us not only to build the machines but also to empower other European organisations to create their own Precious Plastic Workshops, besides upgrading the flux of production.

In 2019 Buinho created a Communitarian Recycling Center in Messejana, based on the Precious Plastic Machines, with mould-making capabilities and substantial investment in educational activities. This has been the first Community Plastic Recycling Center in Portugal, where we teach local communities to separate different plastics and transform the waste into new products. We have built the machines for the recycling centre of Messejana and made the machines for other regional and international organisations, such as the United Nations Development Program in São Tomé e Principe, as part of adult training initiatives.

The FabLab / makerspace environment of Buinho has enabled the development of the machines and its moulds. For instance, the design of the moulds to cast the plastic and parts of the recycling machines can be made through digital fabrication, involving skills in 3D modelling and electronics in the process of machine building. Furthermore, the different precious plastic machines can be built by reusing electronic waste, such as electric ovens (for the compressor machine), metal tubes and resistances (for the extruder machine) and motors (for the plastic shredding machine).

The Precious Plastic space developed in Messejana is currently used for the sensibilisation of adults and families from local communities that visit and attend workshops, but also by the artists of the international artists in residence programme developed by the Buinho association. The artists who use the space come to Messejana to learn about the process of plastic recycling and to use the different machines to develop personal projects, some of which in co-creation and with the support of the inhabitants of Messejana.

Robisz.to | Maker Woman

A training cycle was implemented five times between 2017 and 2019, aimed at women looking for a way to create their product and wanting to return to the labour market after maternity leave and improve their skills. According to an internal evaluation, more than 60% of graduates currently use the tools and knowledge gained during the project. Many of them have entirely changed their specialisation and profession using their new skills. Project graduates have obtained funds for the further development of their products with a total value of over PLN 100,000.

Support under the project included: a series of specialised training courses on new technologies and crafts, which resulted in the independent production of prototypes of their products by the participants, professional mentoring, and technology consultations with experts. Additionally, experts in marketing, intellectual property law and patents, and business experts were involved in the project. Participants also participated in networking activities with investors and business angels and learned about the tools for seeking funding.

The resulting projects include a breathing device, prosthetic hand made in 3D printing technology, vermicomposter, electronic shadow theatre, ecological material solutions and innovative processing methods.

Workshops of Culture | MediaLab Lublin Battle

MediaLab Lublin Battle was a project which gave Lublin programmers, artists, researchers, sociologists and others an opportunity to get to know each other, better understand the specifics of their work to cooperate in the future, and finally compete with each other by creating MediaLab projects.

MediaLab was understood within the project as a form of action that allows people with different skills to work together and learn on innovative projects using new media and technologies. The project was open to programmers, graphic designers, musicians, artists, sociologists, electricians, designers, managers or cultural animators. By increasing the exchange of experience and knowledge between people representing different professional groups, it was possible to work on projects aiming at the convergence of multimedia and technology.

All project participants participated in 9 workshops led by experts in medialabs, internet, gamification, design thinking, social media, big data, new media and technologies. The participants had at their disposal: drones, 3D printers, Kinect cameras, Arduino controllers, GoPro cameras, laptops, tablets, CNC, etc. The participants created a few multidisciplinary teams which worked on their project ideas. The task to be performed and the main challenge for the participants was to find a significant problem for the inhabitants of Lublin which could be solved within the framework of the created prototype solution. All teams had to implement their own original experiment / medialab project. The general theme of the project was the city of Lublin.

All teams competed for points which were available for: attendance, quality points given by the trainers and by the other groups, Internet voting, particular tasks (like creating a project website or organising an event premiere) and the significance of the problem tackled by the project (additional points were given to projects that raised or solved a significant social issue of the Lublin inhabitants). The team with the most points ultimately won a valuable prize – a trip to the Expo in Milan.

An additional dimension of the project was the recognition of the local potential and the training of future educational staff for the newly emerging Medialab Workshop of the Workshops of Culture.

A form of continuation of MediaLab Lublin Battle were two editions of Youth MediaLab, also using the formula of cooperation with people with different skills and competencies, as well as gamification rules, which showed the importance of both well-defined and solved problems, as well as a good presentation of ideas.

Buinho | Makerspaces and COVID-19: Digital Fabrication initiatives to produce protective face shields

The sudden onset of the COVID-19 pandemic brought a new experience to Buinho at different levels and territorial scales. Similarly to many other makerspaces and FabLabs, its 3D printing equipment, laser cutting and know-how in 3D modelling and vectorial design became very relevant in the initial context of the lack of response from local authorities and sellers to provide protection face shields to health professionals and populations. In April 2020, public health professionals from hospitals in the Alentejo region were wearing diving goggles due to a lack of professional masks and asking us for help through social media channels. In the area where we are, Buinho became the only FabLab with the production capacity of designing and printing face shields to distribute freely at the health care and social institutions of the Baixo-Alentejo region and its coast. For example, the fireman, the local police, nursing homes, hospitals, day-care centres, and public schools.

For this reason, we were called to assume a stance on adult education by supporting capacitation initiatives in 3D printing amongst adults of the Baixo-Alentejo region who had their equipment at home and institutions with 3D printers but were not in use due to a lack of knowledge. As a result, an informal network of citizens was formed and clustered. A platform of distributed manufacture of face shields arose as a grassroots civil initiative. This local initiative also engaged members of the senior population, who contributed with their knowledge in crochet and sewing. While in Buinho, local schools and municipalities with digital fabrication equipment were printing the face shields and gathering sponsorships for materials, senior ladies were crocheting soft ear protections to complement the printed PLA plastic structures of the face shields.

One year later, in April 2021, as an unexpected result of this initiative, we were invited to provide adult education training in Cape Verde, on the Islands of Maio and São Vicente. We offered adult education courses in 3D modelling and printing and capacitation initiatives in digital fabrication to start a small network of makerspaces within the archipelago to foster new digital competencies for local people. The courses were divided into two parts, one where the participants learned how to assemble a 3D printer and fix its problems and the second part about 3D modelling. The course also had content about digital fabrication technologies and the FabLabs / maker movement to contextualise the use of 3D printing and its potentialities. Not only in terms of producing COVID-19 protective face shields and swabs but also different utilities, objects and substitution pieces of devices that are broken.

Workshops of Culture | Linking technology and culture

Since Workshops of Culture is a cultural institution, we always intend to link activities based on digital technology with culture and art.

One good example was the “Milling, programming and sound painting” project. It was a series of open workshops based on the “Museum of Sound”[16] project coordinated by the Association “Based in Warsaw". The project gathered the sound recordings of 23 old folk instruments coming from different cultural backgrounds. All instruments were also photographed and described, which enabled the creation of a publicly accessible compendium of information about them. Our idea that originated from this project was to transform digital objects into real ones. In this way, we combined the use of new technologies based on a FabLab concept and the knowledge of cultural heritage.

We divided the workshops into two cycles: CNC milling and sound programming. Recruitment was open for participants who wished to join either one or both of the cycles. Participation was free and only available to adults. Previous CNC or programming experience was not required. Experienced trainers led both cycles.

A workshop on CNC milling was conducted to create tangible objects – folk instruments – from plywood. Participants learned how to prepare files for cutting and how to operate a CNC milling plotter. Each participant worked on a specific instrument. There were four sessions of four hours each.

The next step was to make the wooden instruments play. To do so, we used Bare Conductive paint and touch boards. It is a popular tool that enables turning touch into sound, light, or data. The participants learned how to write a program to play sounds (on an Arduino-based board) and planned the sound effect using electric paint and conductive tapes. They created the final objects and played with them! The workshops lasted for two days.

Workshops like this were a fun way to apply new technologies to adult cultural education. In addition to learning CNC and Arduino programming, the participants gained knowledge of world musical heritage. A

[16] http://www.instrumentyludowe.pl/en/

“make to learn” philosophy and team effort underpinned the project. Experienced educators facilitated the workshop, and the workshop organisers provided technological resources. From the learners' perspective, it was important that the workshops were free of charge and did not require any special knowledge or skills.

Aalto Fablab | Fab Academy – Digital Fabrication

Fab Academy teaches the student a method of developing a prototype and skills to use digital technology tools and machines to build one. It also teaches how to document and share the work with others. Documenting and sharing the document helps the community continue developing the prototype; sooner or later, the prototype is more than a prototype, product, or service. Fab Academy is a very demanding course; within six months, the student makes a vast knowledge leap depending on their background, education and field. But in any case, the course or learning programme offers new skills and a more comprehensive range of methods for prototyping and manufacturing.

Fab Academy is a very good introduction to digital manufacturing. The course is very practical. The students will learn some theory behind documenting, designing, electronics and mechanics, learn the basic skills to fabricate physical things, and finally manufacture their project with their hands and communicate it to others.

Aalto Fablab was established for random needs of the departments of the School of Art, Design and Architecture (Aalto ARTS). Although it was open for the students and staff of the whole university, it was constantly under the threat of budget cuts. The value of open spaces in the university, especially costly ones like workshops, can easily be undone. That is why it is essential to bind workshops and education together. At the Aalto ARTS was a course called Digital Fabrication that very much reminded the Fab Academy. The course has been held in FabLab ever since the lab was established. We run Fab Academy as a separate thing in the beginning and, at some point, started to discuss and plan to merge the two courses. Everything happens slowly in the university bureaucracy, which is often not bad. Firstly, it was essential to pilot the combination of having both graduate students and others in the same course, which worked well. The course needed to be structured a bit differently to get the students to plan their individual study plans more efficiently. The whole course would give a maximum of 27 ECTS, but students can choose whether they want to take only a part or the entire course content.

The course fee of Fab Academy varies globally between 2500€ and 7500€. The recommended price is 5000€, including the fee of 2500€ (or 2500 US$) to the Fab Foundation. Because in Finland, all education is free of charge from primary school to a doctorate, the graduate students cannot be asked to pay the fee in this case either. The Fab Foundation runs the Fab Academy and naturally needs to be paid for the organisation of the global course. It arranges the study plan, networks required for the international lectures, websites, and the shared database for documentation and the students’ work. Because the graduate students do not pay, they either get access to that database. Still, as the documentation is an essential part of education, we established an equivalent concurrent database for the graduate students. If so, a student can pay and join the global course, they get credited by the university and get a global evaluation of their work. The University of Oulu in the north of Finland also runs Fab Academy for its students and others. They have solved the payment of the fee very much like us, but they have also budgeted grants or stipends for the students.

The paying students are essential to get access to global lectures organised every week. Each year we have had one or two paying students. As Aalto Fablab is a university unit, we do not have the resources to market the courses, and so far, it has mainly happened by word of mouth. Aalto University has a particular unit for training professionals, but it is designed for executives and bigger student groups. It did not suit selling Fab Academy as training professionals.

Three Digital Fabrication courses run parallel to the global Fab Academy lectures and follow the same distributed educational model. The first set of lectures in the course series introduces the essential skills and knowledge in digital fabrication, focusing on creating prototypes, products, and machines that include embedded electronics.

Students will learn basic computer-controlled cutting, 3D printing and scanning, and electronics production skills. They will also learn essential project management skills, version control tools and skills needed to document the learning process, and how to manage project development.

The second set deepens the students' skills and knowledge in digital fabrication with a focus on creating prototypes, products, and machines that include embedded electronics. They will also learn how to design and create interactive systems using microcontrollers, sensors, motors, actuators, and other electronic components that are integrated into custom circuit boards. The course also introduces tools, techniques, and processes for computer-controlled machining, mould making, and casting.

The last set of courses focuses on developing a final project demonstrating the skills and knowledge gained from the previous courses. They will also be introduced to tools, techniques, and processes for system integration, networking and communication protocols, and future possibilities for developing and disseminating their projects and designs.

Quite recently, Aalto University established a new approach to Life-wide learning[17], through which it offers courses for anybody. At the time of writing this paper, we are defining the rules to amend the Digital Fabrication course as part of the Life-wide Learning offering.

In the future, the Digital Fabrication course series will be a minor study program for two Aalto schools, ARTS and SCI. Usually, the course has had graduate and doctoral students from many schools of Aalto University, which has a multidisciplinary impact on education. This is also desired, but in the future, it would be worth experimenting with joining the education between two or more FabLabs, so that particular expertise needed in a case could be obtained from another FabLab. Also, it would be good to swap instructors between the FabLab nodes.

[17] https://lifewidelearning.aalto.fi/en#/

Evaluating FabLab users

To support cooperation and shared practices between the project partners, an **evaluation questionnaire** was created to explore the profile of FabLab users (adult learners). Its purpose was to gain insight into FabLabs' audience profile and to provide us with a deeper understanding of their needs.

Our discussions revealed common themes in the behaviours and learning styles of FabLab users. We identified three user groups that we felt had distinguishing characteristics:

- **Learners**, use the FabLab mainly to learn.
- **Makers**, use the FabLab mainly to make.
- **Entrepreneurs**, use the FabLab mainly to prototype.

Through the project, we wanted to create a learner profile for each group to better understand and respond to the needs of our users. The questionnaire was developed in English (see Appendix), and then each project partner translated it. Data gathering varied between partners as some gathered data during courses, and others asked users in the lab to respond. This resulted in 150 responders from 5 countries answering the questionnaire. Differences in data gathering methods between partners resulted in slight problems with comparisons. But seeing that the aim of the questionnaire was not based on rigorous scientific methods and presented to a small group of respondents, the comparisons did not affect the results. The learning experience from this work is valuable knowledge and an exciting starting point for further research.

The overview of the questionnaire results allowed us to compare learning styles based on skills, how the FabLab users identify themselves in the lab and their reasons for visiting, as planned. Before asking the users, the project partners shared their knowledge of what people do and how they use the lab and learn. The questions asked were based on our shared practices and questions that would be informative to know. As seen in Chart 1 below, the questionnaire supports our assumption: Learners are most likely to come to the FabLab to learn, while Makers come to do something new, and Entrepreneurs come mainly to work on specific prototypes.

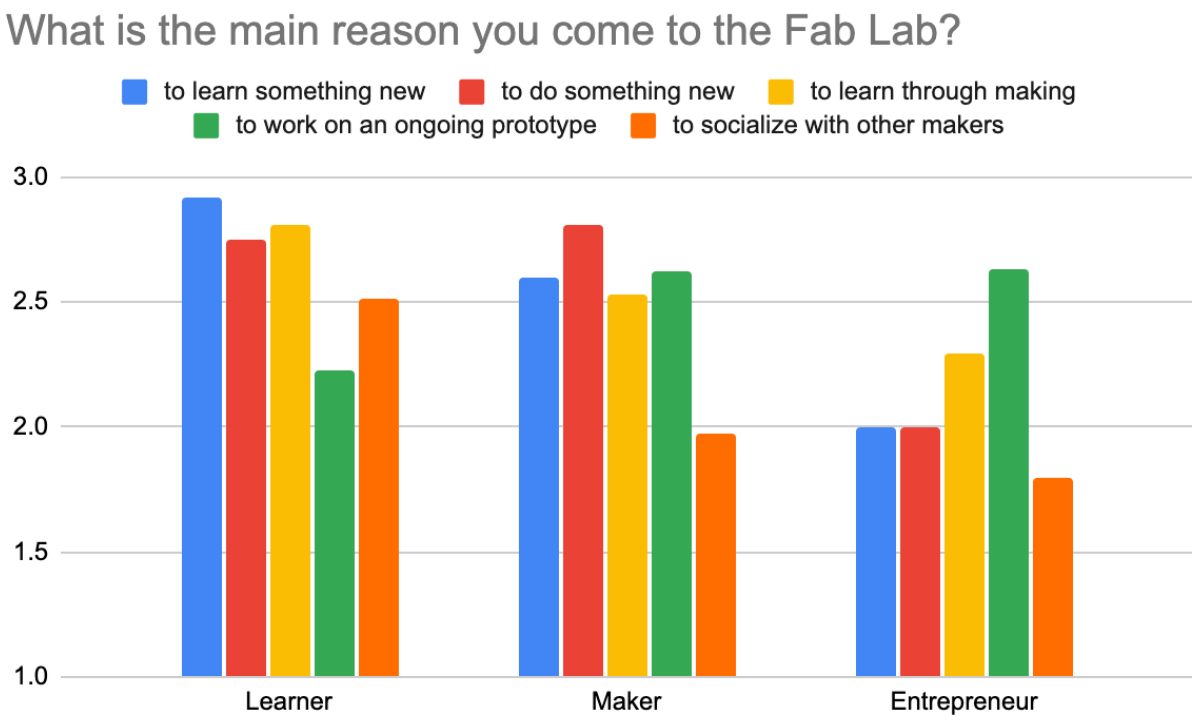

Chart 1 What is the main reason you come to the Fab Lab?

Then the questionnaire was explored further by looking at: if users identified themselves as makers, learners or entrepreneurs. The result showed two large groups of learners and makers and a small group of entrepreneurs.

When we explore learning styles, we can see that overall the most preferred type of learning by our users is to attend a workshop with a planned maker project, followed closely by “gathering information and then doing it myself”. This would qualify as a project-based learning method. When learning styles are explored between groups, there are distinguishing features, as shown in Chart 2 below.

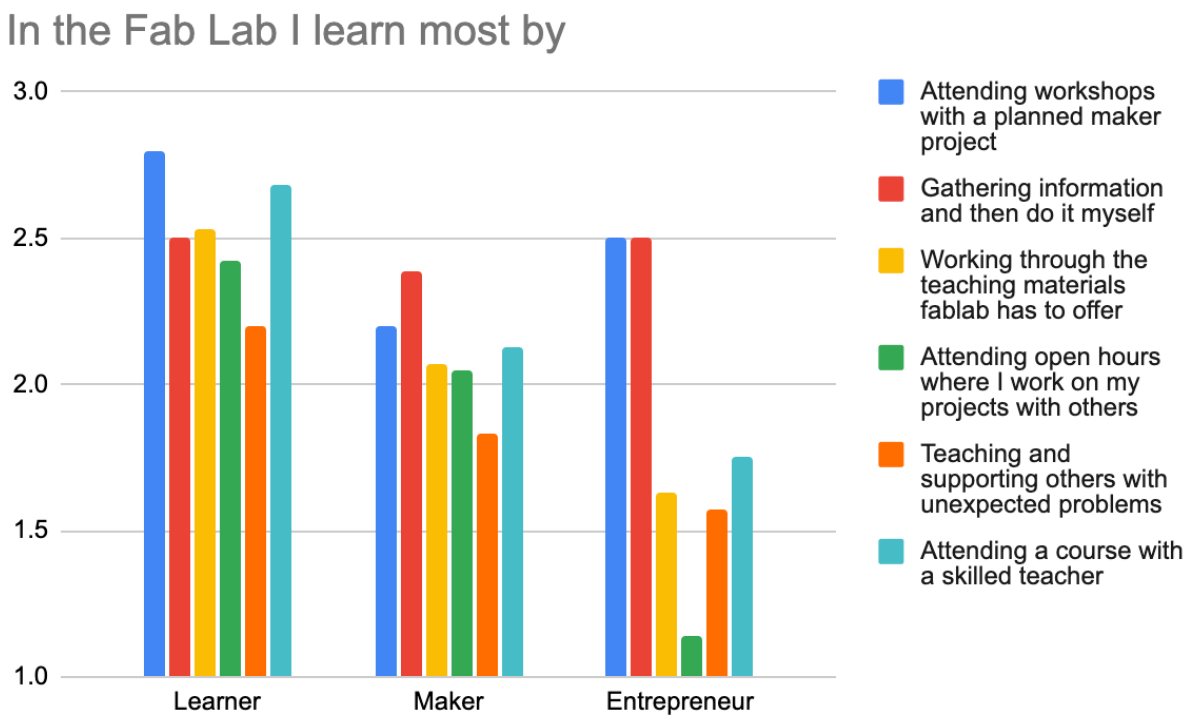

Chart 2. In the Fab Lab, I learn most by

Chart 2 shows learners that like structured learning methods, either by attending a planned workshop or a course with a skilled teacher. Makers mostly prefer a problem-based process of gathering information and then doing it themselves, closely followed by attending workshops. Like makers, entrepreneurs share the preference for project-based and problem-based learning by attending workshops and gathering information by themselves. The questionnaire confirmed that FabLabs have a variety of users and that different approaches are valued and needed to personalise user development.

Interestingly our most skilled users, the professionals, and the instructors have differentiated preferences in learning. The instructor likes learning by solving complex problems with others, while the engineers prefer to figure things out by themselves. Skilled instructors often have a greater urge to help and share their knowledge with others.

Learning experience

The starting point for the conception of the evaluation questionnaire was its purpose and the utility for the partners' structures and beyond. We have asked ourselves the fundamental question of why we should convey the survey in the context of this project and, more specifically, what should be its content, to contribute substantially and pertinently to the development of the subject of adult education.

As a result of this joint effort came the questionnaire that brings added value to the exchanges of experiences and sharing practices that have been happening between the partners throughout the project lifeline. The content of the questionnaire, and the questions posed, expresses the points of interest shared between the partners.

The feedback received, in terms of quantitative participation and the information provided, reflects well the particularity of each partner's structures. (e.g. the size of the structure and the part taken by the

FabLab/makerspace within the structure, the environment and the socio-geographical context, and the type of the activities proposed). At the same time, with this questionnaire, the partners have been aiming to deepen their knowledge about their publics, to go beyond what they can understand from the habitual exchanges (in the occasion of training, workshops etc.).

Thus, the following paragraph is about the survey's process and results. Each partner shares thoughts about the experience, the feedback they have received and what it brought to their organisations.

Aalto Fablab | Finland

We published the questionnaire for the users of the FabLab that were on the e-mail list. It was open for three weeks and was answered by 50 respondents. At the end of the process, we organised a lottery where three people were picked to obtain a 50 EUR voucher to be spent for materials available at the Aalto Fablab.

Most respondents were students (Aalto Fablab is part of a university). However, they categorised themselves as something else. Some students already have their companies when they join studies. At this point, they may perceive studies as complementary to their entrepreneurial activity.

From the answers that we received, it was possible to tell that we are consistent in terms of building a community. We see a similar number of respondents who have been coming to the FabLab for a few years and those who have just joined.

Artefacts | France

The questionnaire was sent out accompanied by an e-mail re-explaining the context of the survey and its purpose. We have also discussed it in person during the workshops.

First, working with other European structures and adapting the questions to be helpful to each partner has been highly enriching. It was an exciting process of reflection which showed that even if our ways of working and our audiences are different, our questions remain the same because the objective is ultimately the same: to give access to knowledge through practice to all types of public.

From the questionnaire results, we have learned that our public is in the age range of 30 to 50 years and that most of them have been using the workshop since the very beginning, even if they are still not very diligent with some of the tools and processes. This feedback gives us the necessary "food for thought" that motivates us to initiate actions to feed the assiduity of our public (through thematic workshops or other punctual gathering activities). We also plan to offer activities to attract younger adults (from 18 to 30 years old).

Buinho | Portugal

The survey was applied in a series of full-day workshops that Buinho organised for young adults enrolled in second-chance professional schools. That explains why Buinho shows a very significant number of answers from younger adults compared to other FabLabs in this study.

The survey was also applied to the Buinho artists in residence that uses the FabLab and attends our workshops and volunteers of the FabLab. The age range is very diverse within these two publics (16-40 years of age) and their skills. The total of respondents was 38.

The survey has been translated into Portuguese and distributed in a printed format to the participants at the end of each workshop. The English version of the survey has also been used and given to the artists in residence at the Buinho Fablab since all of them are foreigners using the studios and doing their personal projects at the FabLab.

We found that the volunteers of Buinho were happy to answer the survey and the residents. On the other hand, the students from the professional courses were surprised by some of the questions, and the survey got them to think about their learning experiences.

As a non-profit organisation, Buinho deals with very different public types and diverse social backgrounds. Some of the respondents had difficulties understanding the survey questions, and the Buinho staff was asked to support them.

Fab Lab Reykjavík | Iceland

The survey was put up on dedicated computers, and the FabLab staff explained its purpose and asked people to answer the questions.

We learned that we were pleasantly surprised by how willing people were to give us 5 minutes of their time. Additionally, we realised how much the staff underestimated the time needed to ask people to take the questionnaire. Because we wanted to get a wide range of users, it was often an afterthought that we managed to ask them to answer.

This process made us wonder: is it more efficient to send out questionnaires via e-mail rather than asking them personally? And the answer we have come up with is: To ask people in person.

Because many of the people we asked are not registered on an e-mail list, we still believe this was the better choice. It is possible, however, that we would not have gotten enough responses via this method. We already have a way of asking people how they liked the workshops. Still, this survey and analysis of the data gave us new insight into our work and concrete replies to questions that we felt we had the answers to beforehand without any data.

We also learned from the other labs that our processes and people are different, and discussion paths would be great for us to look into adding to the lab's communication.

Robisz.to | Poland

The survey was sent out to people participating in workshops, long and short-term projects, volunteers, and people using FabLab on a subscription basis. To send out the questionnaire, we used, among others, the Discord platform, which FabLab uses for communication.

People were enthusiastic about filling out the questionnaire.

We learned that the most effective way to collect responses to the questionnaire is to ask people directly at the workshop. We got more responses from people participating in one-time workshops or short-term projects than volunteers and people using FabLab on a subscription basis as entrepreneurs. We also learned that some people liked seeing themselves as learners and workers. Only a few felt competent enough to consider themselves teachers/ participants in the peer-to-peer learning process.

Workshops of Culture | Poland

The process of gathering the feedback was organised through an online questionnaire sent to all participants of various activities developed by us in recent years. The feedback clearly showed us that adults come to us to learn something new and choose particular topics of the activities that interest them the most, either to learn how to make something by themselves or just to learn something new. They prefer activities led by someone (a trainer, an instructor) and consider the Medialab Workshop as a learning space and a place to try something new. What we learned through this questionnaire is that we need to strengthen the educational aspect of our activities – to pay more attention to creating a good learning environment, in terms of a better prepared physical space, but also cooperating with educators who are prepared to work with adult learners. The questionnaire results also confirmed that our users/learners appreciate a wide variety of activities in terms of their topics and favour those activities that lead to learning something practical and valuable, and gaining knowledge that can be applied in various contexts.

The process of working jointly on the conception of the questionnaire itself has been an enriching experience allowing the partners to discover differences and common points when creating the learning environment. For example, choosing the questions that correspond to each structure's interests brought up the subject of lexicon and the culture we share. This has often led the partners to research and agree upon the standard definition of the terms we would refer to throughout the project, in the questionnaire and in this publication.

Each partner had a different way of approaching the process of distributing the forms and communicating around the survey. As the shared feedback shows, this has been very much connected to each structure type, the context and the particularities of the activities we provide. Moreover, our users/learners have different profiles (e.g., students in Aalto, young adults in Buinho, professionals in Robisz.to) and thus, their attendance patterns and habits in the FabLabs differ.

The fact that all of the partners' structures share the educational mission allows us to share, compare, be inspired by each other's practices and hopefully, inspire the larger public with the outcomes of our work.

This feedback gives the first glimpse at the differences and similarities within the consortium that influenced our cooperation and its final results, which are presented in this document.

Learning outcomes and their validation

The project activities, especially a number of working sessions between project teams, allowed us to discuss learning outcomes of our activities and how we validate them within our organisations. In the same way that our structures differ formally, so does our validation process.

During the discussion of this topic, learning outcomes were defined as the specific knowledge or skills that learners acquire as a result of a learning activity. This should be done by creating a program of the learning activity (training/workshop/course/learning program) that includes a description of the expected learning outcomes. For adult learners, it is particularly important to provide information about what they will learn after the learning is completed and which skills/competences the activity will develop. It makes the learners more engaged into their learning path, and make the educators more aware of the importance of creating a clear and doable learning program. Lastly, clearly defined learning outcomes facilitate assessment and evaluation.

In the case of FabLabs, it is particularly important to make it clear what the learners will be able to do upon completing the learning activity. Initially, it refers to a machine or tool that a learner can operate independently after following certain instructions. An instruction manual is often placed alongside a machine/tool to guide this process. Therefore, the learner knows that following these instructions will lead to certain results. However, it is also crucial for a learner to understand that the machine is only a tool and that it can be used to develop personal projects. FabLabs should be equipped with prototypes and ready-to-use products produced using machines to inspire creativity and demonstrate possibilities, so that learners can see what is possible, how things can be done, and what challenges they may face as they use the machines. Additionally, it illustrates that mistakes and failures are essential components of learning. This is that part that clearly shows how FabLabs stimulate both STEAM specific competences (in science, technology, engineering, the arts, and mathematics) and the development of 21st century skills (including creativity, collaboration, communication, critical thinking, initiative, problem solving and social skills) in learners.

This combination makes it quite challenging for FabLabs to evaluate, assess and validate the learning outcomes, especially outside of the formal learning system. While discussing this subject we have asked ourselves for example whether formal assessment structures can really address a broad array of objectives and how various assessment tools can support learning in FabLabs. In this context some examples were shared by the partners. In particular, **a presentation of learner's final project** (as a result of a completed learning activity), reviewing it by an educator/peers and having a discussion about working process and challenges along way were praised by the partners and used most often. This method makes the learner more aware of and focused on the learning path, and also more responsible for the whole process. The partners value also **peer- and self-assessment**, which allows the working group to assess

their ongoing performance and to make adjustments and modifications of their initial plans toward the final product. In this method educators allow learners to reflect critically on their experiences, learners are encouraged to learn from their mistakes and use them constructively for improvements and they can reflect on the importance of working collaboratively. Our organisations focus therefore on **informal methods of assessment**, which includes also giving a regular feedback from the educator and using specific evaluation tools, like questionnaires/surveys at the end of the learning activity. The informal assessment methods lead to **informal validation approaches** that mostly include certificates issued by the activity organizer after a completion of the learning program or building a portfolio that document the learning process. Our approaches are more focused on building self-awareness and helping a learner understand the skills and competences in the first instance. This help the learners to reflect on the competences gained and how they could be used in different ways in the future.

Reflections & Recommendations

We started this project with a strong belief that FabLabs and makerspaces are places that do not only serve as a source of innovation and productivity but also that they favour quality learning experience because – in opposition to most of the classic school context – there is no fixed objective, no imperative of production, no competition which allows (and even encourages) to make mistakes and thus, gain in knowledge, in skills, in understanding. These places, with the accompaniment and without pressure, offer a gratifying and satisfying learning experience where the user/learner can create and "make" / produce from A to Z with their own hands.

What we have learnt within the project is that despite the fact of cultural, economic or political differences between our countries, despite the differences in educational systems or in the way our organisations are structured and function, we all are dedicated to ensuring the best possible learning experience to our users/learners. And it goes from providing adequate learning space (both physical and virtual) to creating various learning paths that suit the best individual learners' needs, and finally, to recognising and validating learning outcomes. The biggest lesson we gained through the project is that it takes everything to provide a valuable learning experience.

Throughout the project, we met and discussed our approach to education and learning on several occasions. We also had a chance to visit each partner organisation and observe its space and activities. It was a very valuable experience, and it showed us that despite the similarities in our equipment and activities, each structure has its working model and approach to learning. And this comes very much from the fact that what we offer is an answer to the needs of our learners and users. We all try to put learners at the centre of the learning process and adjust other elements to their learning needs and expectations. We all try to collide with people with various backgrounds, being students, entrepreneurs, designers, engineers or artists – people who have maker-mind-sets – to discuss, create and innovate prototypes, products and services and finally implement them for businesses or common good, as the FabLab concept carries the idea of an accelerator of serendipity. This ideal picture can happen if some effort is invested in the action, and there must be clear rules on how to share the limited resources with other users and how to take care of the cleaning and maintain the spaces and machines. It would require an enabler or a community builder that gathers the community. Very often, the users of FabLab appear to work with a device – they do what they need to and disappear with their creations without saying anything. The FabLab and the community around it do not necessarily gain anything. The ideal would be that there was a community around the FabLab and that it would be a self-learning or peer-learning place where the users are both educators and learners.

In our opinion, FabLabs and makerspaces are valuable learning environments for students, entrepreneurs, and hobbyists. FabLabs and hundreds of similar organisations enrich their surrounding environment and add beneficial diversity to educational methods. They also deserve support at all levels: locally, nationally and internationally.

Through our many discussions, we have identified key elements of more structural support for FabLabs and makerspaces. In general, they can be categorised as follows:

Promotion and marketing of the idea & sharing success stories

- promoting the idea of Life-long and Life-wide learning, e.g. through educational campaigns
- broader dissemination of success stories, such as successful projects and careers
- more evaluation on hands-on experience and learning

- promoting FabLabs as “Third spaces” and as places to learn in a creative way
- promoting FabLabs as spaces for second-chance and continuing learning
- showing how investing in FabLabs and technical skills can bring some revenue / new ideas / green solutions
- promoting FabLabs as safe places to learn and experiment for all age groups
- promoting gender equality and social inclusion in FabLabs

More robust networking between various structures on the national and European level

- more networking not only between FabLabs but also makerspaces and hackerspaces
- more possibility of staff exchanges on national and European/global level
- creating national and European associations/networks/lobby groups
- creating common FabLabs standards that refer to equipment, training offer, staff, safety issues
- investing in technical and social skills of FabLabs staff, as machines only make the opportunity, but people are the true asset

Stronger cooperation with the educational, economic and political system

- closer ties between FabLabs and the market; e.g. through companies sending their employees to FabLabs for a training period to acquire specific skills and knowledge
- better recognition of the value of technical learning by the education system – FabLabs can be perfect places to learn specialised knowledge, such as a library is a great place to learn how to find information
- closer ties between FabLabs, the creative sector and the concept of sustainability
- stronger connection to school and VET education system; including maker know-how and digital fabrication into the school curriculum – validation of manual skills as much as intellectual ones
- stronger connection with local production, a focus on sustainability and green solutions

More substantial financial and formal support at local, national and European levels

- recognition of the value of FabLabs on the municipal level
- basic support offered by municipalities (e.g. rent subsidies, special grant system)
- a grant system/programme for individuals to spend a more extended period in a FabLab (either in the same or in a different country)
- investing in people as much as in machines – supporting the development of social and soft skills
- more stable funding – budgets that are less dependent on projects and grants
- creating a European validation system (diploma/certificate) for digital fabrication (European version of the Fab Academy)
- creating a FabLab training offer for unemployed people supported by the national subvention system (as a part of the vocational training system)

We hope the above list will inspire FabLabs and makerspaces, as well as relevant stakeholders and policy actors interested in supporting FabLabs as an effective learning environment. It can also be an inspiration for future Erasmus+ projects, which can address adult education, vocational education & training, higher education, or even school education, as a FabLab concept can be applied to many different fields.

Finally, we would like to underline that according to the evaluation questionnaire conducted within our Erasmus+ project, the main reason to come to a FabLab was to make something new and work with a personal project. However, a significant number of the respondents agreed or somewhat agreed that chatting with other makers was also a reason to come. This shows that as much as production and innovation in FabLabs are desired and they strongly support the democratisation of production and technology, FabLabs also serve as places that foster and support communities – they can be seen as potential “Third spaces” (understood as places where people spend time between home – “first” place and work – “second” place) with a relatively low entry threshold, therefore accessible to a wide variety of

groups, including those at risk of social exclusion. Places that promote and foster creativity, learning and social integration. This vital factor should be considered by the FabLabs operators themselves and the authorities and stakeholders supporting their development. As already mentioned in this publication, we – as the project partners – strongly believe that machines only make the opportunity, but people are the true asset!

Appendix | Questionnaire form for FabLab users

This questionnaire aims to gather information about the FabLab user's/learners' profiles to improve their learning experience.
The questionnaire was prepared within the "FABLABs – new technologies in adult education" project (Strategic Partnerships in Adult Education). The project is supported by the Erasmus+ Programme of the European Union.

1. What is your professional status?

- a student / a pupil
- an employee
- an employer
- freelance/independent
- in search / in transition
- other situation

2. What is your age?

- under 18
- 18-30
- 31-40
- 41-50
- 51-60
- over 60

3. How long have you been a FabLab user?

- this is my first visit
- a few weeks
- a few months
- more than two years
- other – please specify:

Comment:

4. What is the main reason you come to the FabLab?

	strongly agree	**somewhat agree**	**somewhat disagree**	**strongly disagree**
to learn something new				
to make something new				
to learn through making				
to work on an ongoing prototype				
to socialise with other makers				

Comment:

5. On average much time did you spend in FabLab in the past month?

- Less than 2h per month
- Less than 2h per week
- 2h-10h per week
- More than 10h per week

Comment:

6. In the FabLab I learn most by:

	strongly agree	**somewhat agree**	**somewhat disagree**	**strongly disagree**
attending workshops with a planned maker project				
gathering information and then doing it myself				
working through the teaching materials FabLab has to offer				
attending open hours where I work on my projects with others				
teaching and supporting others with unexpected problems				
attending a course with a skilled teacher				

Comment:

7. To me, a FabLab is mainly:

- a place of political expression/action
- a high-tech playground
- a workshop
- a concept place
- a learning environment
- a community of like-minded people

Comment:

8. How would you identify yourself in the FabLab?

- as a maker
- as a learner

- as an entrepreneur

Comment:

9. How would you describe your FabLab skills?

- I am a novice
- I know where to start but quickly need support
- I can start working independently and can figure things out
- I am highly skilled and can easily support others
- I am a professional in engineering or related fields

Comment:

10. What are your experiences with learning activities outside the scholar/academic system, such as training/workshops/MOOCs?

- I often participate in the learning of this sort
- I occasionally participate in the learning of this sort
- I never participate in the learning of this sort
- I am a teacher/trainer/educator myself
- other:

Comment:

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