

FORMALAB

Developing transversal and key competences
in open practical workshops

A guide to implement a Formalab

<http://formalab.fr>

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The idea of creating a Formalab is to apply the concept of a Fablab (Fabrication Laboratory) to adult education and to integrate it in a formal educational centre. Formalab wants to provide an innovative answer to the educational needs of young unemployed adults by developing transversal and key competences.

The innovation has to do with the global approach of a group of key competences and transversal skills, with the implication of the users, with the process and with the development of creativity and motivation.

The idea of transferring knowledge from the Fablab model into a new model called Formalab must take its basis of the already developed model of Fablabs. Although we may find some differences between Fablabs around the world, they have clearly established the basic key points that define them. In that sense, their definition and their main characteristics will be our starting point.

This document has two objectives:

- to translate this already established and shared model of Fablab into a “plastic” model useful in an adult education institution;
- to support Fablabs willing to engage in educational activities and to develop partnerships with local educational and training bodies.

To support these objectives, it provides competence related tools that are useful for educators in a Formalab/Fablab environment.

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1. About Fablabs

1.1. The Fablab Model

"**Fablab**" is a short term for "**Fabrication Laboratory**", or, like some people prefer to call it, "Fabulous Laboratory". The concept was developed in the Center for Bits and Atoms (CBA) of the **Massachusetts Institute of Technology (MIT)**, through a course named *How to do (almost) anything*, lectured by **Prof. Neil Gershenfeld**.

A Fablab consists of a set of digital fabrication tools for rapid prototyping, such as milling machines, laser cutter, vinyl cutter machines, electronics workbench, computers and programming tools, supported by open source software. This is a concept created for the community, based on "Learn by doing" education, providing the ideal environment for invention. The projects are conceived in 2D (in the computers) and get real in 3D (by the machines).

What kind of things you can do in the Fablab? Almost anything, it is your imagination that rules! Currently the labs include computer controlled machines with spatial resolution down to microns, and electronics that have time resolution in microseconds. The ability to design and innovate in microns and microseconds puts powerful capabilities into the hands of Fablab users. Communication devices, sensing technologies, building structures, arts and crafts - all are within reach using the tools and materials in a Fablab. High profile projects made in Fablabs include: solar and wind turbines, wireless data networks, a press fit house (no nails, no cement), long range antennas.. It is an exciting and empowering place to create and innovate, and most users are quite passionate about the lab.

This text was adapted from the Sherry J. Lassiter paper
"On the road to the future: Mobile Fablabs for Technical Education".

Before starting with the conditions for being a Fablab, let's emphasize 2 ideas to illustrate the ideals behind the model:

- developing projects at the intersections between bits and atoms;
- exploring collaboratively this interactions rather than making (almost) anything.

1.2. The Fablab charter and the conformity rating

The Fablab network is growing around the world and some criteria summarised in the Fablab charter are helping the creators of such places to situate within the community. Apart from the share of a common set of tools and processes, the openness of the laboratory is one of the main conditions, it has to provide public access and to participate in the global Fablab network.

Fablab Charter

What is a fab lab?

Fab labs are a global network of local labs, enabling invention by providing access to tools for digital fabrication

What's in a fab lab?

Fab labs share an evolving inventory of core capabilities to make (almost) anything, allowing people and projects to be shared

What does the fab lab network provide?

Operational, educational, technical, financial, and logistical assistance beyond what's available within one lab

Who can use a fab lab?

Fab labs are available as a community resource, offering open access for individuals as well as scheduled access for programs

What are your responsibilities?

safety: not hurting people or machines

operations: assisting with cleaning, maintaining, and improving the lab

knowledge: contributing to documentation and instruction

Who owns fab lab inventions?

Designs and processes developed in fab labs can be protected and sold however an inventor chooses, but should remain available for individuals to use and learn from

How can businesses use a fab lab?

Commercial activities can be prototyped and incubated in a fab lab, but they must not conflict with other uses, they should grow beyond rather than within the lab, and they are expected to benefit the inventors, labs, and networks that contribute to their success

October 20, 2012

The Fablab conformity rating is a code that can be used to describe how closely are met the conditions for use of the Fablab label. It is a quick summary of the lab "now", can change over time. The conformity rating is self-assessed or community-assessed.

Rate	access to the fab lab	adherence to the Fab Charter	common set of tools and processes	participate in the larger, global fab lab network
A	at least some free/open public access (but may assess real material costs)	charter explicitly on site and website	has all core tools & processes and possibly more	members actively contribute or collaborate with members from many other labs lab takes part in or leads network initiatives
B	paid public access only, but anyone can join	"in the spirit" of the charter	very close to but missing at least one core machine or process	members actively contribute or collaborate with a few other labs lab keeps up with network initiatives and discussions
C	closed or restricted user group	no mention of charter	difficult to do most fab projects or follow fab tutorials	very little, only passive, or no participation outside of local lab

1.3. Do Fablabs need Formalab?

“It would be useful to think about the way we as a Fablab think about education and training. Therefore we need a methodology. This is where Formalab can be an added value to all Fablabs. It opens up the possibilities to work together with vocational training centres and learn from each other. A lot of workshops developed within the Fablab community stay within this group of users. By formalising a method it could be possible to recombine research results and add a framework to what already exists in a lot of Fablabs. By adding this dimension of a European framework to the work of Fablab trainers, we could open up new possibilities for further development of vocational training and Fablab activities.”

Evi Swinnen, manager of TimeLab in Gent

2. Elaborating a Formalab Model

What do we want to achieve with the Formalab?

The objective of the project is to develop a model to help unemployed young adults in educational processes to develop key competences and transversal skills. It must be useful for any adult educational institution that wants to innovate in methodology to develop these competences with their groups. It must be useful for Fablabs desiring to develop educational and training activities, by themselves or in partnerships with schools and training centres.

2.1. Do educators need Formalab?

The Fablab way of learning is based on blended and open learning, sharing amongst peers and learn by doing. The way each individual learns in a different way and tempo is influenced by the way they get access to and sort information, off line and online. This results in a very individual set of skills and knowledge. Because, in an open structure as the Fablab community, results of research and individual creations are shared in a very early stage, most of the interesting, new, innovative, information available for makers is not (yet) finished or complete. The result is that mostly manuals are not included and the possibilities of future outcomes are always left open. This can be seen as an advantage. Without an a to z manual, learners start building and creating through trial and error and based on their own creativity. They learn to solve problems that occur by helping each other in a very individual one-on-one way, by sharing knowledge and skills. Peer to peer learning is therefore a very important characteristic of the way Fablabs look at training: everyone is an expert in his or her own way. It is within the difference between people and the openness to learn from each other that opportunities lay.

2.2. The Formalab model

What can we take from the Fablab model to apply to the new concept of a Formalab?

Although Fablabs have a whole structure that defines them, only some aspects are useful to define the Formalab concept. The key points have to do with active learning methodologies, the organisation of the space, the equipment available with machines at the interface of programming and producing, the attitude of trainers and learners and the integration in the local environment and in the community.

The initial access to the Formalab is through the educational institution, attending workshops offered by the Formalab. Once the process is finished the "student" can access by himself (or group) to make objects on the principles of a Fablab.

As a result, a **Formalab can be defined by:**

- a specific environment
- the kind of projects elaborated
- a specific trainer role
- the learner position

2.2.1. The Formalab environment

The Formalab needs a specific environment to provide access for individuals or groups to tools and activities for digital fabrication in order to develop transversal and key competences. It may be associated or inserted in an adult education institution.

Regarding the basic infrastructure needed, the study is based in some examples of Fablabs working around Europe. Although dimensions and use of machines may vary, a minimum of standards are recommended in order to get some valid results.

The place

It must be friendly and functional, large enough (at least 60 square metres), equipped with enough electrical outlets and compliant with safety rules (anti-fire standards, standardized electrical installation...) An access to the electrical control panel is advised. Internet access is required. An access to water is needed.

If the Formalab bases some activities on recuperation and recycling, it is advised to have a dedicated space annexed to the main room to store the material.

Let's note that of course Formalab activities can be implemented in an existing Fablab.

The Formalab experimented in Le Puy-en-Velay is located in a space outside of the training centre with a direct access from the street through a green space. The access is free in the meaning that you enter directly in the Formalab, you don't have to walk through an educational building, you don't pass a welcome desk. We have noticed the positive effect on the learners as it quickly became their space. They care about it much more than the classrooms that they may use in the classic training premises: spontaneously, they make sure that the windows are well closed, that the curtains are down, that the door is locked. The material is considered as theirs and they don't want it to be robbed.

Organisation of the space

It has to offer 6 to 12 simultaneous workspaces.

The space should offer both classic tables and high work plans to allow different working positions. The tables and office chairs must be movable to allow separate group tasks. They can also welcome computer workstations and small manual work. The higher table workshops will be used for assembling.

A large whiteboard (or possibly several) is useful for drawings, maps and demonstrations.

Efficient lighting: some tasks such as welding require thoroughness and accuracy. It is essential to have enough light. If the lighting is insufficient, there must be extra lamps. Stronger light bulbs can be installed.

Lots of storage spaces and furniture are needed (strong workshops shelves with strong enough light. It is quite simple to recovery or to build or even.

A "central islet" will allow participants come together to communicate, share, collaborate around a single object in a

face to face position.

Equipment

This is a pretty important part of the Formalab. It is possible to start without dedicated, proper tool, it is more time consuming and less time will be dedicated to the project itself. So this requires some minimal tools which are standard tools for a workshop (screwdrivers, wrenches, vise, saw, drill, glue gun...). In Annex 1, we propose a more extensive budgeted list of tools.

One computer is a minimum. More computers allows to perform various tasks simultaneously:

- A computer workstation for the information search, web crawling, e-mail communication, sound and video communication. A webcam and microphone are useful to make videoconferences with other Fablabs.
- Another for the interface man-machine interface, more powerful must contain graphics software (Inkscape, Gimp, Blender) and dedicated software such as Pycam, Replicator, Arduino. (See list in Annex 1).

Welding workstations with clips, magnifying glass and lamp.

Electronic equipment: Arduino, LEDs, resistors, jumpers, electronics prototyping pads, actuator... (cf. Annex 1).

2.2.2. The trainer role and the learner position

Project-based learning¹ and active learning takes its source in the United States in the beginning of the twentieth century when Dewey launches the learning by doing method. His school-laboratory proposes concrete activities that aim to answer the native desire we have for learning. He believes education needs to be pragmatic, helping learners to think and to adapt to their environment, starting from their interests and developing their autonomy. He wants to modify the traditional teaching approach by putting the experience at the centre of the learning process. Active learning methods include project-based learning, problem solving, case-studies based learning and design-based learning. We can situate the Formalab at the confluence of project-based learning and design-based learning, depending on the learners participating and on the kind of activities implemented. First the Formalab complies fully with the project process as defined by Perrenoud² (2002): it is a collective enterprise managed by the group, it is oriented towards a concrete production (on a broad sense), it implies a set of tasks in which all learners can take an active part (they may vary according to their capacities, their means and their concern), it facilitates the learning of knowledge and know-how in project management (decision-making, planing, coordination) and at the same time it allows identifiable learning outcomes (at least in retrospect) taken from various subject areas. The activities develop communication, cooperation, creativity, and deep thinking; the focus on learning processes and not only to content is an added value (Barron & Darling-Hammond, 2010)³. The evaluation performed during the Formalab workshops will play an important role to empower the learner regarding the learning processes so that they are conscious about the skills they develop. In design-based learning, the learning objectives are concentrated on the making of an object and not on the solving of a problem in order to achieve a final production. Learning is done through designing and making a product. It involves trials and errors (even if sometimes they can be costly). The user learns to work with others (following the DIWO principles – *Do It With Others*). They share the use of the lab with other learners. In a Formalab, “*the doing and the learning are inextricable*” (Blumenfeld et al., 1991)⁴.

The trainer role is the following:

- The trainer is facilitating the work.
- S/he is able to link the activities performed to other educational processes.
- S/he is not supposed to have a previous knowledge of building the object.
- Through participatory observation the trainer is able to evaluate the key competences and transversal skills.

The time dedicated by the trainer to prepare the workshops will depend of course of its nature and of the time available for achieving the project. If the project is too complicated and involves many activities and a variety of knowledge,

1 This paragraph is based on the dossier established by REVERDY C. (2013). « Des projets pour mieux apprendre ? » Dossier d'actualité Veille et Analyses, n° 82, février. On line: <http://ife.ens-lyon.fr/vst/DA/detailsDossier.php?parent=accueil&dossier=82&lang=fr>

2 PERRENOUD P. (2002). « Apprendre à l'école à travers des projets : pourquoi ? comment ? » *Éducateur*, n° 14, décembre, p. 6-11.

3 BARRON B. & DARLING-HAMMOND L. (2010). « Perspectives et défis des méthodes d'apprentissage par investigation ». In CERI (dir.). *Comment apprend-on? La recherche au service de la pratique*. Paris : OCDE, p. 213-240

4 BLUMENFELD P. C., SOLOWAY E., MARX R. W. et al. (1991). “Motivating project-based learning: Sustaining the doing, supporting the learning”. *Educational Psychologist*, vol. 26, n° 3 & 4, p. 369-398.

tools and concepts to manipulate (like for example the assembling of the mini CNC), it seems that there is no need to invest too much time in the preparation of the whole sessions. It would be too much time consuming and the realisation of the plans subject to too many unpredictable changes. It is better for the trainer to dedicate time for the ex-post documentation of the activities. In such project learners and trainers can be considered as equally new to the topic.

Two anecdotes about the attitudes illustrates the equal roles of learners and trainers in the process. The first concerns the organisation of the breaks: they are not formally taken at the mid-morning or mid-afternoon. Short breaks are taken by learners who can go outside when they want: as a result they don't take enough breaks because they want to go on with the object and the trainer has to remind them that they should stop to be more concentrated after. The second illustrates the attitude of learners and their demand towards the trainer. Often in a Formalab process, the trainer doesn't know why, what, where is the problem: s/he has to look on the internet, to ask a colleague, to discuss the matter with the learners, and they accept it fully. Meanwhile, in a traditional classroom situation, the trainer is more expected to have an immediate answer. If this is not the case, s/he may expect minor comments or jokes, but this never happened in the Formalab context.

2.2.3. Formalab projects: activities and workshops

A workshop can be defined as a pedagogical logical unit: it is limited in time with a beginning and an end, it has a meaning, it is understandable, it can be described and promoted as such, it can be evaluated and reproduced, it produces something concrete. A workshop can be made of several activities and workshops can be logically linked together.

The kind of workshops that can be done depend on the availability of several factors: time, material resources, number of learners involved and the willingness of the trainer.

The following table can be used to give a quick view of a workshop with the machines, the duration, and the level of difficulties. It is filled with workshops experimented.

Workshop	Machines & material	Duration	Level of difficulties *****	Kind
Mini CNC <i>Milling machine</i>	Kit mini CNC Tools: glue for wood, screwdrivers, vise, ruler, computer, software.	21 hours	***	Self build kit
Luminch One <i>Motion detection lamp driven by Arduino card</i>	Paper, wood, milling machine, Arduino card, led, transistor, prototyping plate, source code, resistors, motion detector. Soldering iron, tin.	12 hours	**	Ready made machines
Trashbot <i>Construction of small robots based on old toys and trash material</i>	Broken or defective electric and motorised toys collected from bins or sorting centre. Screwdrivers, glue gun, clamps, soldering iron, tin, batteries and some decorative stuff like pipe cleaner, false plastic eyes...	6 hours	**	Object created
Lego Bot	2 Lego Mindstorm with instruction sheet.	3 hours	*	Lego kit

Every workshop should have a standard format and information to make it easy to share and disseminate. An example of a more extensive format:

Title
General Objective
Specific Objectives
Public
Methodology
Individual or group work?
Number of participants per group
General organization
Use of Fablab machines (please indicate which ones) (list of the available machines at the Fablab).
Skills targeted
Material needed, tools, estimated cost
Expertise of the trainer
Organisation (depending on the number,...)
Results
Pictures/video
Other complementary sessions

In annex 2, workshops tested in Formalab in 2012 are described.

To evaluate each workshop there are several possible methodologies: or the distribution of a closed number of points (balls or other) between the different competences, the fulfilling of evaluation questionnaires (cf. Annex 5 & 6), group or individual interviews with the trainer. Evaluation methods and tips are described in part 3, after a brief outline of skills and competences.

Reproducibility

Once a workshop has been developed and implemented, the trainer may have a slightly different position: s/he is more aware of the possibilities to share the task, of the skills needed and used to achieve the project. In that sense the documentation process is important as some trainers will be willing to “reproduce” previously experimented workshops in order to reduce the fuzziness or the inherent uncertainty of Formalab processes. Documentation is a way to share experience. Besides, all designs and processes developed in Formalabs must remain available for other Formalabs and individual users (open, sharing, transferable...). But it goes beyond the documentation concept used in the Fablabs as it permanently includes a pedagogical dimension.

Documentation process includes:

- daily recap of working sessions
- links with theoretical knowledge useful for the activities
- photography of key steps
- filming
- feedback of learners and trainers

The evaluation with the first group implementing a workshop is useful to indicate the key competences they feel are more targeted with the activities. By their evaluation, the trainer can establish which are the main key competences that the workshop is oriented to develop, and put them in the workshop definition.

After this process, the workshop can be disseminated and re-organised with unemployed young adults or other target groups.

2.2.4. A Formalab FAQ

What is a Formalab?

Formalabs are learning environments based on the concept of Fablabs.

Where can I find a Formalab?

A Formalab can be integrated in a Fablab or part of an educational organisation.

What does the Formalab network provide?

The network provides examples of scenarios for implementing workshops having clear educational purposes. It provides tools to evaluate the competences used and developed during the Formalab activities.

Are Formalab open to everyone?

Yes. In practice, each Formalab has different ways of welcoming learners according to its supporting organisation (Fablab, cultural centre, training organisation...). Hours, opening days and registration processes are variable.

What qualifications are required to run a Formalab?

The tutor has to be aware of learning processes, competence development and competence assessment. Depending on the difficulty of the project elaborated, s/he may need technical knowledge as well as programming skills. S/he needs good communication skills, with the learners and within the Fablab and Formalab network. S/he has to be able to behave and act in a fuzzy environment (in the sense that the learning session cannot be fully planned in advance, it is necessary to adapt and react as problems may occur). S/he has to be able to support an heterogenous group, and tutor the share of tasks in a non intrusive way. A team of staff can be organised to support the whole process.

3. Skills and competences

A skill⁵ lies in choosing, using and combining the resources in order to behave in a proper way in a particular context. The resources can be related to a subject (theoretical and practical knowledge, quality, culture, sensibility...) or to an environment (tools, use of documentation, organization...).

It is often acknowledged that a work feature or a skill combines three dimensions: theoretical knowledge, technical knowledge and know how. Wittorski R. gives a definition which is very close to Le Boterf: "A skill is a mobilisation of different knowledge combined for a specific function." A skill is linked to a certain action, so that this action can be considered the visible (and assessable) part of the skill.

A skill can be developed in different contexts of works and situations. But to acquire and develop a skill, the worker must have a reflective activity. We refer to a "I know how to do" which needs theoretical and procedural knowledge (be able to do in a technical way, method, relationships...) and practical knowledge (empirical knowledge).

3.1. Key competences in EU context

The Recommendation (2006/962/CE of 18 December) of the European Community, Council and Parliament, focuses on the development of eight key skills for personal fulfilment, social cohesion and employability in a society of knowledge. The Recommendation is part of the more general Lisbon Strategy which aims at making Europe "the most competitive, dynamic and knowledge-based economy in the world". The development of key skills is one of the goals identified in order to strengthen the effectiveness and the quality of the system. Here a skill refers to a "combination of knowledge, skills and attitudes fit to the context".

The Reference Framework sets out eight key competences⁶:

1. Communication in the mother tongue

⁵ LE BOTERF, G. (1997). *De la compétence à la navigation professionnelle*. Les Editions d'organisation.

⁶ See Annex 3.

2. Communication in foreign languages
3. Mathematical competence and basic competences in science and technology
4. Digital competence
5. Learning to learn
6. Social and civic competences
7. Sense of initiative and entrepreneurship
8. Cultural awareness and expression.

Competence in the fundamental *basic skills of language, literacy, numeracy and in information and communication technologies* (ICT) is an essential foundation for learning, and learning to learn supports all learning activities. There are a number of themes that are applied throughout the Reference Framework, which we can consider transversal: *critical thinking, creativity, initiative, problem-solving, risk assessment, decision-taking, and constructive management of feelings* and that play a role in all eight key competences, so they should be considered.

3.2. Transversal skills

According to the French Strategic Analysis Centre⁷, the transversal skills are generic (and so called by the OECD) and directly connected to the basic knowledge, to the behavioural skills, and to the cognitive and organizational ones. They do not depend on a specific working context and they are also known as fundamental skills, key skills, transferable skills. They are having more and more importance because the workers need them in order to change job during their life. It is necessary to communicate with an increasing number of people, to adapt to new technologies and processes, to solve problems and to take an active part to innovation.

Transversal skills are those that each person uses at work, they are not specifically related to a specific activity or employment status and affect the ability of individuals to express skilful or expert professional behaviours. They combine knowledge, skills and cognitive attitudes.

A survey conducted in the Auvergne Region among twelve companies in 2011 in the frame of the YES-ME⁸ Progress project has emphasised the importance of the following personal and transversal skills.

Categories of personal and transversal skills	Quotations
Cognitive	Autonomy Quickness of mind Stability Capacity to solve problems Capacity to adapt to new techniques
Relational/communicative	Relation with colleagues and clients To work in team Empathy, capacity to understand clients Listening skills Good basic level of education
Strategic/organisational skills	Take into account a global approach Adaptation Capacity to take initiatives
Attitudes	Autonomy Being engaged Being responsible Curiosity (Showing interest for the trademark and the products sold) Dynamism Motivation
	Combative Team spirit

⁷ LAINE, F. « *Compétences transversales* » et « *compétences transférables* », *des compétences qui facilitent les mobilités professionnelles*. – La Note d’analyse travail emploi n°219, Avril 2011.

⁸ Project Progress VS/2011/0081 “YES-ME – Young Employment System For Mobility In Europe”

	Unobtrusive and tactful Quick minded Resistance to stress Flexible in the working hours Business skills Being reliable Calm, confidence Politeness, smiling attitude Being happy at work Being able to work hard Stability Sensitivity Neutrality
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Aggregating these data with a similar survey in the Province of Torino, taking into account companies as well as employment experts, the YES-ME progress project team has decided to focus on developing the following transversal skills and attitudes among the young adults looking for employment or activity.

Summary of main transversal skills

- 1) Organize work autonomously (organize tasks and priorities choosing among several options)
- 2) Interpersonal and relational skills and social integration in the company
- 3) Be able to act in the company (keep to the roles, recognize and analyse the context, observe, listen, keep to rules)
- 4) Effective teamwork
- 5) Communicative skills (first of all with clients, but also with colleagues, to listen) and interpersonal efficiency (understand intuitions, needs, others' attitudes and interact in a constructive way)
- 6) Be able to modify personal behaviour and personal strategies depending on situations
- 7) Efficiency in problem solving and ability to act in difficult situations (problem solving, stress handling or even stress standing)

Summary of main attitudes

- 1) Curiosity, learning motivation and self-investment in achieving the company's goals
- 2) Enterprising: pro-activity, combine actions and behaviour in an independent way
- 3) Flexibility: skill to understand both people and situations' changes, to adapt them to one's environment in order to find the opportunities to achieve goals
- 4) Creativity: orientation to find original and effective solutions not related to traditional or already adopted models
- 5) Reliability: ability to perform the required functions on time and under given conditions
- 6) Maintain a dynamic and positive attitude
- 7) Be accurate and careful (attention to detail: ability to operate with precision and care by determining the good quality of the work performed)

3.3. Evaluation of skills

After the workshops developed in Formalab, we propose a four level evaluation and measurement process. Depending on the time and objectives of the trainer one or several levels can be chosen. Let's note that even if the trainer doesn't want to enter deeply in the competences, it is important to dedicate a moment for a group discussion giving all learners the possibility to express their feeling about the process. It is also important to keep in mind that the main purpose of any evaluation process in a Formalab environment is to make learners aware that they already master skills that are used in real work environments and to focus on the skills that are demanded by companies. The learner knows his/her strengths and weaknesses, what s/he can valorise and where s/he has to improve.

3.3.1. Evaluation the workshop

When: at the end of the workshop

Goal: demonstrates insight in parallel thinking and gives feedback

Tools: video messages and coloured balls

Process: learners give individual feedback on video. After this the group discusses the feedback given while trainer introduces the coloured balls. After given an example by the trainer making use of what is said, learners each get 1 or 2 balls and are asked to give feedback in a specific colour.

Result: overview of direct opinions and a lot of material for sharing experiences in the level 4 evaluation.

3.3.2. Self-assessing competences

When: ultimately 2 days after the workshop

Goal: insight in the six colours of feedback (based on the DE BONO six hats) and showing that learners can use this as a self assessment tool. Trainers get an idea of the level of competences very short after the workshop.

Tools: 8 baskets marked with the 8 EU key competences. Camera.

Process: Coloured balls for each learner. 8 transparent containers or baskets. At each basket the trainer explains the meaning of the colours according to the key competence. The learners drops in the coloured ball according to his opinion. This process is repeated 8 times. Take a picture of the result.

The Six Hats Model

Communication expert Edward De Bono⁹ developed the Six Hats Model, also known as parallel thinking. This model is used in contexts for developing skills on communication, discussion, problem solving and decision-making. Because of the visual character it is also very popular amongst young adults and teenagers. This is a perfect tool to stimulate critical thinking. The six hats represent six colours. Each colour symbolizes a different point of view.

White: objective, facts

Green: creative, ideas, outside the box

Yellow: positive, benefits, improving, best case scenario

Black: Negative, criticism, worst case scenario

Red: emotional, subjective, intuitive

Blue: rational, summarizing, weight, well thought, but critical

An example of expressions transferring these opinions to the acquisition of key competences could be:

White: It's true, I can prove it to you

Green: Suddenly I got an idea, I will for sure use this in another context

Yellow: This is going well, I really progress because...

Black: This is going bad, I don't see it, because ...

Red: I don't know why, but that's how I feel

Blue: on the one hand ... on the other hand ... but also ...

3.3.3. Post workshop behavioural assessment (Short version)

(Based on the 8 key competences)

When: between 4 and 9 weeks after the workshop

Goal: Trainer is able to observe and estimate the growth of level of competences of the learners. This could be also a great tool for an individual one-on-one evaluation.

Tool¹⁰: Skills, knowledge, attitudes / Beginner, Confirmed, Experienced grid (cf. Annex 4). This grid is based on the EU Key Competence Framework that describes each of the eight macro competence in skills knowledge and attitudes. Then for each of them an attempt is made to distinguish three levels of mastering, called here beginner, confirmed,

⁹ DE BONO, E. (1997) Thinking course, Redwood Books

¹⁰ This model is adapted from the work by MCCLELLAND D. (1973), *Testing for Competence Rather Than for Intelligence*. and DREYFUS & DREYFUS (1980) in *A Five Stage Model of the Mental Activities involved in directed Skill Acquisition* applied to the European reference framework of key competences for lifelong learning (L.394 20061230).

experienced.

Process: Trainer makes individual scorecards and discusses it with the individual learner.

Result: Learners learn to understand the divergence between their self assessment and the assessment by the trainer.

3.3.4. Post workshop behavioural assessment (Large version)

(Based on transversal skills, attitudes and knowledge)

When: between 1 to 5 days after the workshop

Goal: During the workshop, the trainer observe the behaviours of the learners and he can estimate the level of each learner. By filling a visual questionnaire, the learner is conducted to make the same analysis, ex-post. The questions answered show him/her the diversity of skills needed by companies and facilitate their identification.

Tool: Questionnaire (Annex 5)

A shorter self-evaluation tool is proposed in Annex 6. It is focused on the key competences in relation with the transversal skills they are linked to. This grid is for the learner to fill before a personal interview with the trainer.

Process: Trainer gives the printed questionnaire to each learner with the instruction to colour the cells of the first line until it corresponds to his/her estimated level. The second line is completed after the workshops, in discussion with the trainer.

Result: Learners become familiar with skills and attitudes demanded by any working environment. They learn about themselves through the exchange with the trainer. They can detect progress areas and engage to follow them.

3.3.5. Trainers evaluation of the process

When: 10 weeks after the workshop

Goal: Invite educators to participate in the process of life long learning. Provide feedback to other trainers and organisations involved in trashbots. Feedback on the used methodology.

Tool: email containing 3 questions:

- Describe in 1 paragraph how the workshop changed your own teaching methods and style.
- Describe what you think will be the impact of this on the learning results of the learners
- In what way could this workshop and assessment method be more efficient?

Process: by email, answers can be done on a wiki, blog, youtube, email, Facebook or Formalab website.

4. Annexes

4.1. Annex 1. List of equipment and tools

Screwdriver sets

Spanner sets (flat, allen...)

Hammer

Hand files, sanding sheets

Cutters

Scissors

Pliers

Clamps

Multimeter

Hot melt glue gun and glue.

Glue

Vices

Ruler

Drill and drill bits

Soldering station (adjustable temperature) and solder

Furniture storage

Trash/garbage

For more information, several Fablabs put the list of their resources on internet.

4.2. Annex 2. Workshops implemented in Formalab

Mini CNC, milling machine
General Objective: Build a milling machine
Specific Objectives <ul style="list-style-type: none">- Use tools- Assembling,- Interpreting isometric schemes- Acquire knowledge in electricity, electronics,- Working in group- Experimenting a positive training experience in a work-like environment.
Public: Young adults far from the labor market with mental and cognitive disabilities
Group work and share of tasks according to skills and preferences
Adapted to 5 to 8 participants
General organization: Depending on the steps learners have worked in group, in pairs or alone
No use of Fablab machines but assembling a Fablab machine
Main skills targeted <ul style="list-style-type: none">- Communicating in French- Mathematics and sciences- Digital skills- Collaborative work- Accuracy- Understanding skills in English- Capacity to take initiative
Material needed, tools (estimated cost around 800€ - with all tools) <ul style="list-style-type: none">- Mini CNC Kit- Usual tools
Expertise of the trainer <p>Knowing how to solder. Basic technical knowledge in electricity and electronics. Open attitude, capacity to work in a fuzzy environment.</p>
Results: The milling machine is working
Pictures/video: see the http://formalab web site for illustration and process of the workshop
Following sessions: Parametrizing the machine. Using the machine to mill wood, cardboard, plastic.

Luminch One lamp
General Objective: Build a lamp where you can change the intensity
Specific Objectives <ul style="list-style-type: none">- Use tools- Assembling,- Interpreting isometric schemes

<ul style="list-style-type: none"> - Acquire knowledge in electricity, electronics, - Working in group - Acquire Gcode notions - Using the digital milling machine
Public: Adults on a key competence development program
Methodology: acquisition and construction of basic pieces, following instructions in English
Exchange within the group, individual work for making own lamp
The experiment was done in a small group of 4
General organization: Individual work to elaborate own lamp. Collaboration to solve difficulties.
Use of Fablab machines: the milling machine can be used (it is not compulsory)
Skills targeted <ul style="list-style-type: none"> - Communicating in French - Understanding skills in English - Mathematics and sciences - Digital skills - Collaborative work - Accuracy
Material needed, tools <ul style="list-style-type: none"> - Casual workshops tools (here we have also used the milling machine to adapt some parts of the lamp) - Arduino, led, motion detector (estimated cost around 40 € per lamp)
Expertise of the trainer No specific expertise. Basic technical knowledge. Open attitude, capacity to work in a fuzzy environment.
Results: All learners have built their lamp.
Pictures/video: see the http://formalab web site for illustration and process of the workshop

Building robots with LEGO, moving the robots
General Objective Learn how with a simple construction game we can build a little robot and how they interact with the environment.
Specific Objectives <ul style="list-style-type: none"> - Learn to work in a team. - Learn to work with a specific task. - Learn to solve little problems. - Learn to build Lego ®.
Public: Young people with low handicaps and not motivated to study.
Methodology: A duration is allocated (3 hours) and the logo robot kit is given to each group.
Group work
Number of participants per group: 4-6 members per group.
General organization Two groups, two robots, we learn to build a robot a test different sensors and they relation with de environnement.

We try to learn a basic and simple programming. We try to solve little problematic situations (detect objects and change the direction...).
Main skills targeted <ul style="list-style-type: none"> - Learning to learn - Sense of initiative and entrepreneurship - Cultural awareness and expression
Material needed, tools, cost: Lego Mindstorms ® (around 300 euros to buy a kit that can be reused a lot of times).
Expertise of the trainer: The trainer need basic knowledge about Lego Mindstorms ®
Organisation: Two trainers for 10 or 12 students. Other trainers are welcome to participate.
Results: Build two robots and test different sensors. Ultrasound sensor for detecting objects near the robot, sensors of light and sound, sensor of touch.
Pictures/video: see the http://formalab web site for illustration and process of the workshop

Trashbot workshop
General Objective: Elaborating robots based on electric toys recycled from trash
Specific Objectives <ul style="list-style-type: none"> - Awareness of recycling, programmed obsolescence - Recognizing some components - Use tools - Learning who to solder - Acquire basic knowledge in electricity, electronics, - Developing creativity and imagination - Experimenting a positive training experience in a work-like environment.
Public: Young adults in vocational integration path (with mental and cognitive difficulties)
Exchange within the group, individual work for making own robot
Number of participants per group: possible from 5 to more (depending on the material available)
Organization: Depending on the development of the workshop, learners have worked in group, in pairs or alone
Skills targeted <ul style="list-style-type: none"> - Social and citizenship skills (recycling...) - Creativity - Digital skills - Collaborative work - Accuracy
Material needed, tools, estimated cost: 20 to 50 euro for a 8 to 10 group <ul style="list-style-type: none"> - Old toys - Glue guns, soldering irons
Expertise of the trainer Knowing how to solder. Basic technical knowledge. Open attitude, capacity to encourage creativity.
Results: construction of small moving robots.
Pictures/video: see the http://formalab web site for illustration and process of the workshop

4.3. Annex 3. The EU Key Competences reference framework

1. Communication in the mother tongue	Communication is the ability to express and interpret thoughts, feelings and facts both in oral and written form (listening, speaking, reading and writing), and to interact linguistically in an appropriate way in the full range of social and cultural contexts — education and training, work, home and leisure.
2. Communication in a foreign language	Communication in foreign language broadly includes the main mother tongue skills: it is based on the ability of understanding, expressing and interpreting thoughts, feelings and facts in both oral and written form (listening, speaking, reading and writing) in an appropriate social contexts range — work, home, leisure, education and training — according to everyone’s wants or needs. Communication in foreign languages includes also mediation and intercultural understanding skills. The proficiency degree varies between the four dimensions, the different languages and according to the individual’s linguistic environment and heritage.
3. Mathematical literacy and basic competences in science and technology	Mathematical literacy is the ability to use addition, subtraction, multiplication, division and ratios in mental and written computation to solve a range of problems in everyday situations. The emphasis is on the process rather than the output, on the activity rather than the knowledge. Scientific literacy refers to the ability and willingness to use the body of knowledge and methodology employed to explain the natural world. Technology competence is viewed as the understanding and application of that knowledge and methodology in order to modify the natural environment in response to the perceived human wants or needs.
4. Digital competence	Digital competence involves a reliable and critical use of electronic media for work, free-time and communication. These competences are related to a logical and critical thinking, to a high-level information management skills, and to a well-developed communication skills. At the most basic level, ICT skills include multi-media technologies to collect, assess, store, produce, present and exchange information, and to communicate and participate in networks via Internet.
5. Learning to learn	Learning to learn includes the disposition and the ability on organise and regulate one’s own learning and communication, both individually and in groups. It includes the ability on time managing effectively, problem solving, acquiring, processing, evaluating and assimilating new knowledge, and applying new knowledge and skills in different contexts — at home, at work, in education and in training. In general terms, learning to learn contributes strongly to managing your own career path.
6. Interpersonal, intercultural and social competences, civic competence	Interpersonal competences includes all kinds of behaviours to master in order to have an efficient and constructive social life and to solve conflict if necessary. Interpersonal skills are required for an effective interaction on a one-to-one basis or in groups, and are used in both the public and private domains.
7. Entrepreneurship	Entrepreneurship has an active and a passive component: it includes both the tendency to personal changes and the ability to welcome, support and adapt innovation from external factors. Entrepreneurship involves taking responsibility for one’s actions, positive or negative, developing a strategic vision, setting objectives and meeting them, and being motivated to succeed.
8. Cultural expression	‘Cultural expression’ is the importance valuation of the creative expressions of ideas, the experiences and the emotions in media as music, corporal expression, literature and plastic arts.

4.4. Annex 4. Skills, knowledge, attitudes / Beginner, Confirmed, Experienced evaluation grid

Levels: 1. Beginner; 2. Confirmed; 3. Experienced

Communication in the mother tongue

	Skills	Knowledge	Attitudes
1.	Repeats vocabulary in class with the help from the trainer	Understands the proposed definitions of different terms	Expresses the intention to use the terms
2.	Used vocabulary in class without help	Knows the terms and their meaning	Wants to use the terms amongst peers
3.	Uses vocabulary outside class	Knows the terms and takes initiative to extent vocabulary	Reformulates and encourages peers to use terms

Communication in foreign languages

	Skills	Knowledge	Attitudes
1.	Repeats foreign vocabulary in class with the help from the trainer	Understands the proposed definitions of different foreign terms	Expresses the intention to use the foreign terms
2.	Used foreign vocabulary in class without help	Knows the foreign terms and their meaning	Wants to use the foreign terms amongst peers
3.	Uses foreign vocabulary outside class	Knows the foreign terms and takes initiative to extent vocabulary	Reformulates and encourages peers to use foreign terms

Mathematical competence and basic competences in science and technology

	Skills	Knowledge	Attitudes
1.	Uses tools and machines guided by trainer	Understands the showed procedure	Shows a positive attitude towards techniques and technical skills
2.	Uses tools and machines without help	Knows the method of producing a technical product	Shows an inquisitive attitude towards techniques
3.	Uses technological skills and knowledge in other contexts	Understands the meaning of technology and the use for society	Looks for technical solutions for new challenges

Digital competence

	Skills	Knowledge	Attitudes
1.	Is able to look for necessary information with help from trainer	Understands the use and pitfalls of digital data	Shows a positive attitude towards ICT and digital data
2.	Is able to look for relevant information on the web, interprets and applies it.	Knows digital tools and its positive and negative sides.	Shows an inquisitive attitude towards digital tools
3.	Looks for information and collect information in a critical way to solve digital challenges	Understands the possibilities of digital instruments as supporting tools	Shows an enthusiastic approach towards digital tools to peers

Learning to learn

	Skills	Knowledge	Attitudes
1.	Uses the provided documentation with help from trainer	Has an idea of his own level of competences through the use of the evaluation method	Has a positive attitude towards learning and being taught.
2.	Uses the provided documentation on his own for the workshop	Understands the method of evaluation and learning	Shows an inquisitive attitude towards the used training documentation and evaluation methods
3.	Knows how to organize, interpret and adjust it's own learning process	Knows methods to gain, assimilate and communicate information on his own or in a group	Has a learning strategy based on a constantly changing context

Social and civic competences

	Skills	Knowledge	Attitudes
1.	Works together with others on an assignment guided by trainer	Understands the use of working together and his own role	Has a positive attitude towards social interaction and social responsibilities.
2.	Works together with others on an assignment	Has insight in his own social behaviour and his influence on others	Is prepared to change his own behaviour in favour of the cooperation with others
3.	Uses gathered insights in other contexts.	Has insights in a responsible relation towards nature, animals and resources.	Looks for new ways of responsible behaviour and shows it

Sense of initiative and entrepreneurship

	Skills	Knowledge	Attitudes
1.	Recognizes obstacles and calculates risks, helped by trainer	Understands the link between what is taught and best practices in society	Shows the intention of using the skills developed in the workshop
2.	Is capable of dealing with risks without help	Sees why technical skills, procedures and security matters are useful in life	Shows initiative and uses the taught skills
3.	Is a role model in handling risks and safety matters	Teaches others on where knowledge can be found and helps peers to gain knowledge	Has a leading position in the search and elaboration of new projects

Cultural awareness and expression

	Skills	Knowledge	Attitudes
1.	Is able to produce something useless as a self expression, after positive feedback	Is able to see the connection between what is made, art and culture, with help from peers	Shows the intention of looking for possibilities behind negative feedback
2.	Is able to produce something useless as a self expression	Is able to see the connection between what is made, art and culture	Is able to give feedback to peers in a constructive way
3.	Is able to stimulate others in making something useless as a self expression	Is able to rank what is made within a group of art objects	Is able to give feedback to peers in a constructive way and express growing opportunities

4.5. Annex 5. Evaluation of skills, attitudes and knowledge

Formalab Workshops

Evaluation of Skills, Attitudes and Knowledge

[This evaluation format is planned in two steps. It is given to the learner with the instruction to colour the cells of the first line until it corresponds to his/her estimated level. The second line is completed after the workshops, in discussion with the trainer.]

ATTITUDES

I am pragmatic

I can bring ideas

I take initiatives

I am strongly involved in the tasks to achieve

I am enthusiastic and motivated

I can work in autonomy

I am able to guide the group

I am constructive

I show that I am determined to achieve my work

I can establish priorities

I ask advises and feedback

I am able to manage urgent matters

I am able to solve problems

I can face stress

I can learn by myself

I am able to sort out information

I am able to invest in a project

I am able to manage complex things

DURING THE WORKSHOPS

I have used skills in mathematics

Which ones?

--

I have used a computer

For which purposes?

--

I have used a foreign language

I have interpreted schemes (3D schemes, electronic...)

I have performed practical tasks

Which ones?

--

What else did you learn?

Do you think the *Formalab* workshops will be useful for you in the future? Why?

Would you advise this kind of workshops to other colleagues?

Please do not hesitate to formulate any other comment, ideas, suggestions.

Thanks for taking time answering these questions.

4.6. Annex 6. Post-workshop self-evaluation of key competences linked to transversal skills

This is an evaluation form for the workshop you did related to the Formalab Project.

For each key competence, please indicate in which degree you think this workshop helps developing each characteristic.

Afterwards, please mark with different colors the relation you find between the key competences on the left side with the transversal competences on the right side. Use RED when you want to show a strong relation; use BLUE when you want to show a relatively strong relationship; use GREEN if you want to show a weak relationship. If you think there is no relationship between some of the competences, please do not mark anything.

▲ Fully ▲ A lot ▼ A little ▼ Not at all

Key competences

Communication in the mother tongue:

Listening ▲ ▲ ▼ ▼
 Speaking ▲ ▲ ▼ ▼
 Reading ▲ ▲ ▼ ▼
 Writing ▲ ▲ ▼ ▼

Communication in foreign languages:

Understand spoken messages ▲ ▲ ▼ ▼
 Conversation ▲ ▲ ▼ ▼
 Produce text ▲ ▲ ▼ ▼

Mathematical competence and basic competences in science and technology:

Use of technological tools ▲ ▲ ▼ ▼
 Use of scientific data ▲ ▲ ▼ ▼
 Reach a conclusion ▲ ▲ ▼ ▼

Digital competence:

Collect information ▲ ▲ ▼ ▼
 Understand complex info ▲ ▲ ▼ ▼
 Use of Internet-based services ▲ ▲ ▼ ▼

Learning to learn:

Learn autonomously ▲ ▲ ▼ ▼
 Work collaborately ▲ ▲ ▼ ▼
 Share results ▲ ▲ ▼ ▼

Social and civic competences:

Communicate constructively ▲ ▲ ▼ ▼
 Show tolerance ▲ ▲ ▼ ▼
 Feel empathy ▲ ▲ ▼ ▼

Sense of initiative and entrepreneurship:

Self organisation ▲ ▲ ▼ ▼
 Effective representation ▲ ▲ ▼ ▼
 Team working ▲ ▲ ▼ ▼

Cultural awareness and expression:

Appreciation of others work ▲ ▲ ▼ ▼
 Cultural expression ▲ ▲ ▼ ▼

Transversal Competences

Critical Thinking

Creativity

Initiative

Problem - solving

Risk assessment

Decision - taking

Constructive management of feelings