IN EDU

Informal and Nonformal Education in Fab Labs

An analysis, mapping, and selection of the educational format used in Fab Labs

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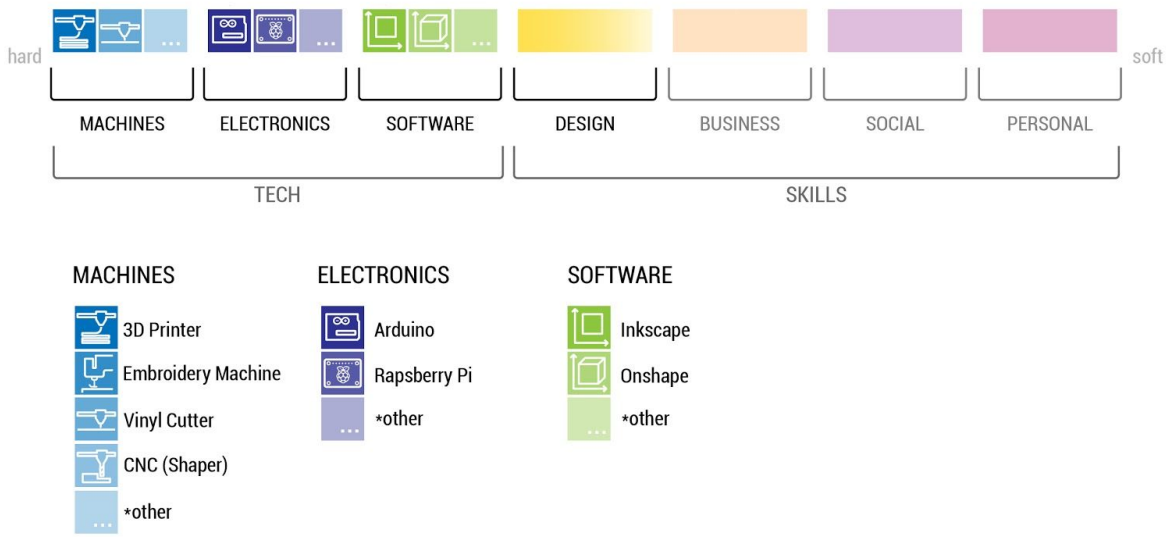
Hypothesis of structure

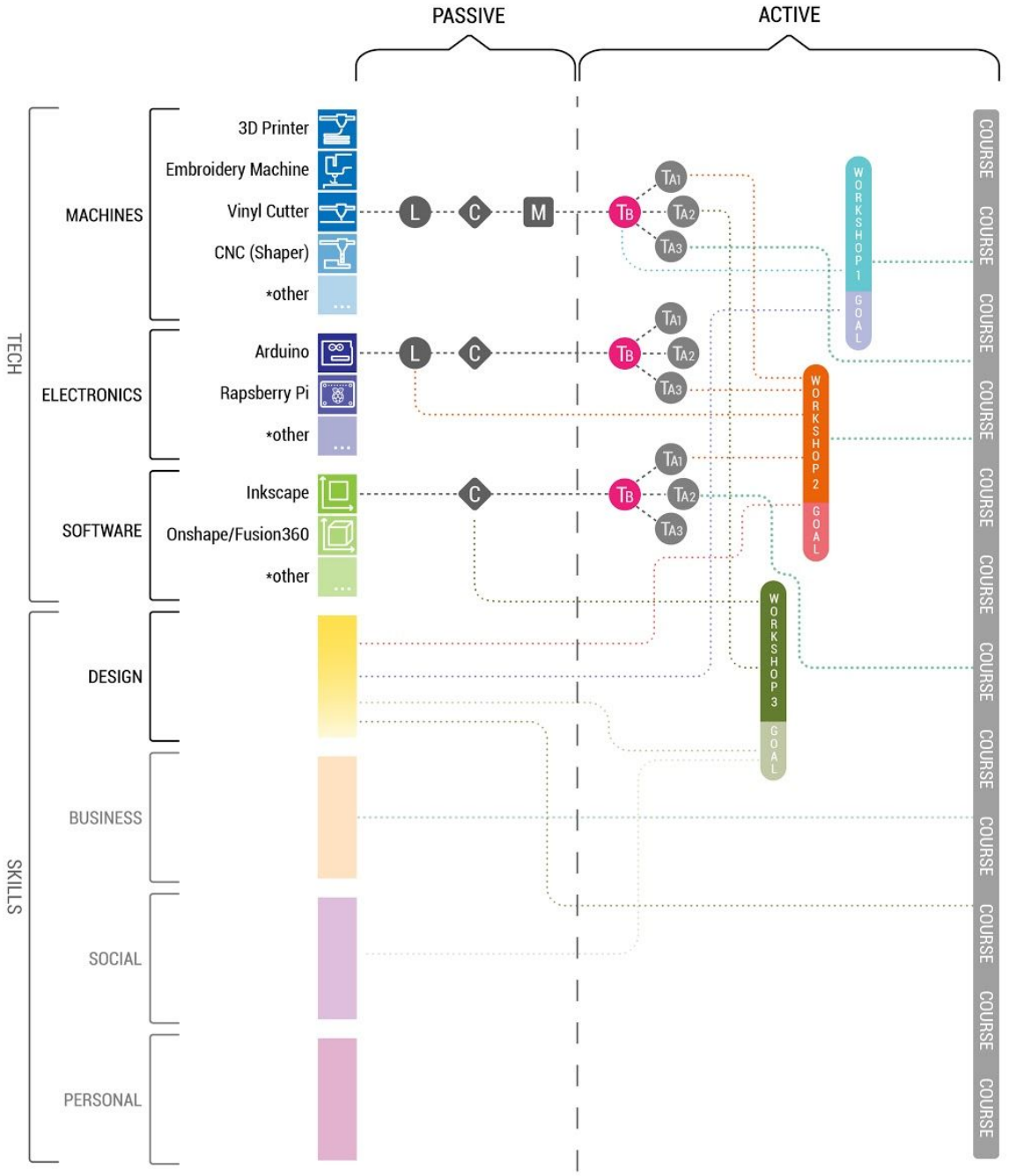
We defined a possible subdivision of activities two different ways:

1. **Tech vs. Skills:** based on the fact that the objective is to learn a technology or improve a skill. We will focus on technologies, considering there is another team working on some of the skills (business in particular) and to optimize the use of the Fab Lab machines.
   Machines, electronic boards, and software selected are based on the inventory used in Burkina Faso and Ukraine. We identified the following solutions:



2. **Passive vs. Active:** some materials are just an organized list of things to know (how to assemble a machine, how to operate it, basic info on what you can do with the tech, etc.) these formats don't require an active involvement. On the other side, every hands-on Fab Lab activity is based on an active involvement of the user. Both formats must be implemented: passive formats are useful to support users in repetitive procedure or easy to forget operations; while active formats imply participation and a proactive mindset

Here a schematic visualization of the overall structure:



L Introductive Lessons

TB Tutorial (basic)

M Manual

C Cheatsheet & Checklist

TA Tutorial (advanced)

Categories of Educational Formats

We identified seven (7) different kind of educational formats, based on the **objective** (why you do it, what's the final goal), the **tools** necessary (which kind of machine or tool is required to produce the output), and what's the concrete **output** produced (a 3D printed part, the proof of concept of a new idea, a solution to a problem given, etc.)
In the following table, the different formats are described:

	Active\ Passive	**Objective**	**Tools**	**Output**
Introductive Lessons	passive	Be introduced to possibilities and limitations of a new tech	No tool needed	X
Cheatsheet & Checklist	passive	Remember features and tricks, get better designs	No tool needed	X
Manual	passive	Build, maintain, and fix	The tools described in the manual	X
Tutorial (basic)	active	Learn the tool (a single specific machine\tech)	A single machine \ tech	An example of what the tool can do (irrelevant what)
Tutorial (advanced)	active	Learn a feature or application of the tool (a single specific machine\tech)	A single machine \ tech	An example of what the specific feature of the tool can do (irrelevant what)
Workshop	active	Learn something else, apply tech knowledge, improve skills, work in groups, etc.	Multiple machines \ techs + skills	A (physical) realization of the "practical brief" given as an input (i.e. make your own radio, or interactive lamp)
Course	active	Be empowered, be proactive, improve personally, integrate different skills, etc.	Techs + skills + theory	It depends on the given "design brief" (i.e. "design a solution to grow food indoor", could have as an output a hydroponic greenhouse)

Just to avoid misunderstanding, we reported the definitions:

1. **INTRODUCTIVE LESSONS**
    - **Duration:** few hours, usually less than 4
    - **Typology:** “one to many” lecture \\ “one to one” lecture \\ self study
    - **Description:** to understand how a technology works it’s usually necessary to have a general introduction to understand the meaning of terms used and context implied.
    - **Example:** fabacademy lectures, done by prof. Neil Gershenfeld, are a good example of how to introduce complex topics in a brief time to a non-homogeneous audience. The format is “one to many”, like what happens in a normal college classroom. http://fab.academany.org/2018/lectures/

      On a completely different level, this arduino comic is designed to be used as introductory material to understand how arduino works. The target is much younger and it could fit both the “one to many” model, or the self study one. https://playground.arduino.cc/uploads/Main/arduino_comic_v0004.pdf

2. **CHEAT SHEETS**
    - **Duration:** few minutes
    - **Typology:** self study material, reminders
    - **Description:** summary tables containing design information about the topic, general rules, best practices, things to remember, etc. it’s usually in a format that can be printed and hung on the walls
    - **Example:** a lot of softwares or technologies have their own cheatsheet, here some examples found online, for the TdH Labs it could be necessary to design some version not heavily relying on written language

      Arduino:

      https://i2.wp.com/tinkrlearnr.com/wp-content/uploads/2017/11/arduino_cheatsheet_poster_blue_green.jpg

      https://github.com/liffiton/Arduino-Cheat-Sheet/blob/master/Arduino%20Cheat%20Sheet.pdf

      3D printing:

      https://core-electronics.com.au/media/wysiwyg/tutorials/aidan/3dP/practical-printing-poster-png.png

https://steemitimages.com/p/62PdCouTvNPCrqBxU3fPZCSSbPckTWZJwBQbuxrF2csspjrdov29N2jS5KRpiuQEyxTGpBC7ubKt6iNiGWGCk1E8oXUXo2NEAATchNZkgZhJPWf

https://www.simplify3d.com/support/print-quality-troubleshooting/

3. **CHECKLISTS**
    - **Duration:** few minutes
    - **Typology:** self evaluation support.
    - **Description:** complex procedures that are not performed daily can be tricky to remember properly. Simple inattention can cause the fail of the process or a very poor result. A checklist is a useful tool to self evaluate the completeness of the starting process of a machine
    - **Example:** a good example designed for the 3D printer "ultimaker" is the following. It is designed to guide the user in setting up the machine after the 3D model has been designed: https://ultimaker.com/download/18439/Checklist.pdf

      A different approach is used by an online supplier, "iMaterialize". In this case the checklist is to verify that the model is properly designed and exported: https://i.materialise.com/blog/en/preparing-files-for-3d-printing/

4. **MANUALS**
    - **Duration:** depends on the activity\machine. From less than an hour to multiple days
    - **Typology:** self study
    - **Description:** a manual is a list of instructions to assemble, maintain, and fix the machine. It is usually done by the producer of the technology and it's relative to the specific model of the machine used. If TdH will decide to produce or modify a machine, the production of such a manual must be taken in consideration.
    - **Example:** one of the best 3D printer manual is the Prusa I3 one: https://manual.prusa3d.com/c/English_manuals

5. **TUTORIALS - BASIC**
    - **Duration:** between 4 hours (1\2 a day) and 16 hours (2 full days)
    - **Typology:** 1 to many hands-on class
    - **Description:** a basic tutorial is a first activity done to understand and apply a technology. It's focussing on a single technology and it ends with the physical or virtual realization of an object. The final result is a mere excuse to apply the

knowledge learned. Being the first activity done on a technology, it is meant to be introductive of all the main features

- **Example**: https://www.instructables.com/class/Easy-3D-Printing/

6. **TUTORIAL ADVANCED**
    - **Duration:** between 4 hours (1\2 a day) and 16 hours (2 full days)
    - **Typology:** 1 to many hands-on class
    - **Description:** an advanced tutorial is focussed on an advanced or specific feature of the technology (i.e. “controlling motors with arduino” or “How to thermoform a 3D printed part”). Technology is the goal, the product is a mean.
    - **Example**: an idea of an advanced workshop could be to 3D print a bracelet, to explain PLA malleability when warmed up. The final result is a bracelet, but it’s used to learn specific features. https://www.instructables.com/id/Heat-Forming-and-Making-3D-Printed-Wristband/

7. **WORKSHOPS**
    - **Duration:** between 8 hours (1 full day) and 16 hours (2 full days)
    - **Typology:** mixed, mainly group work and Peer 2 Peer, with some 1 to many contents
    - **Description:** a workshop involves different technologies and\or aims to build a specific solution (i.e. “design and build your own electronic instrument” involves Arduino, 3D modeling and 3D printing). It is designed to allow the users to apply what they learned, be more proactive and work in groups. Technology is a mean, the product is the goal.
    - **Example**: two examples are listed in “C - 5 solution”. Another idea could be: “make your own furniture”, recycling wood panels\plywood and assembling them with 3D printed parts. The process includes other activities and skills beside 3D printing, such as
        - design the object
        - adjust the 3D file to the thickness of the material found
        - Change the angles to fit the length
        - Etc.

      https://www.instructables.com/id/Custom-Hexagon-Shelves-Using-3D-Printing/

8. **COURSES**
    - **Duration:** between few days to few months
    - **Typology:** mixed, integrated different activities. Group work, Peer 2 Peer, self study\research, 1 to many contents, etc.
    - **Description:** a course is the integration of tutorials, intros, workshops, lessons, etc. to create a complete educational program, with a clear pedagogical objective. It should be custom made around the needs of TdH Labs, to fit the specific context, even if the parts integrated could be existing activities.
    - **Example:** a nice example could be the integration between this set of basic lessons (https://www.instructables.com/class/Invention-Class/) and tutorials on the specific technologies needed, such as 3D modeling, laser cutting and 3D printing

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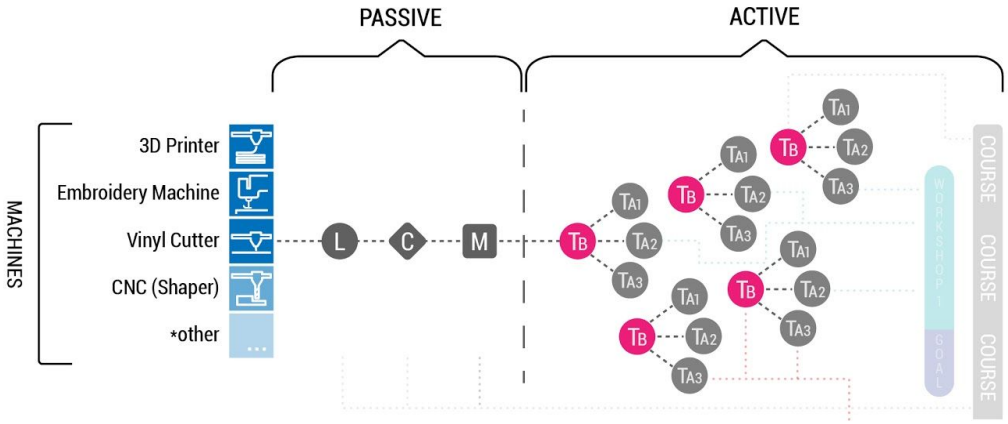
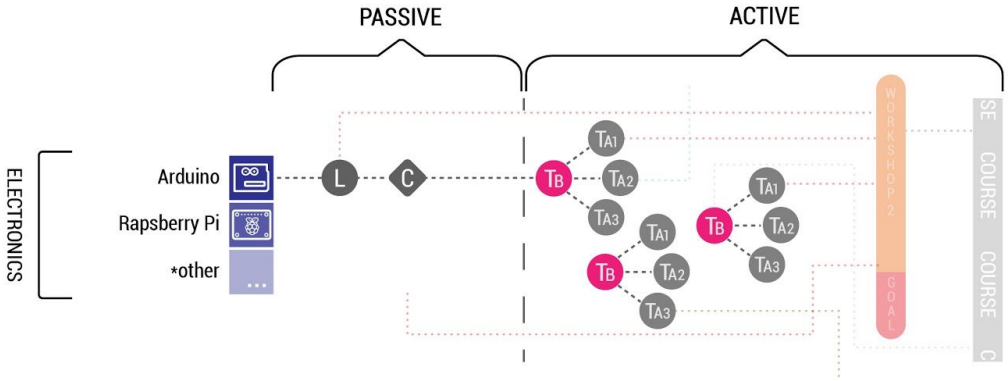
There are some slight differences in structures within the technology area, between passive activities for machines, electronics, and software.

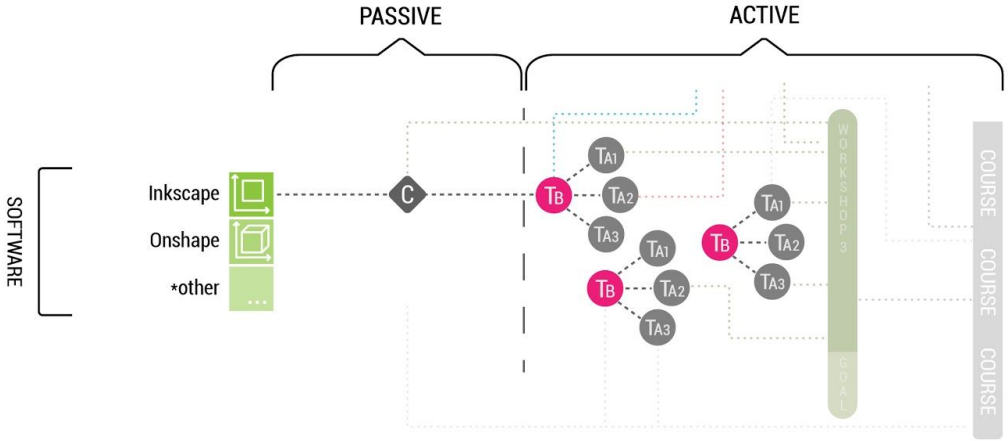


Machines requires all passive formats, allow to develop a wide range of tutorials and can easily integrated in workshops. The workshop example we picked up is based on both Arduino and 3D

printing.



Electronics, on the other hand, requires only introductive lessons, checklists & cheat sheets formats. They allow a wide range of tutorials and can easily integrated in workshops. The workshop example we picked up is based on both Arduino and 3D printing.

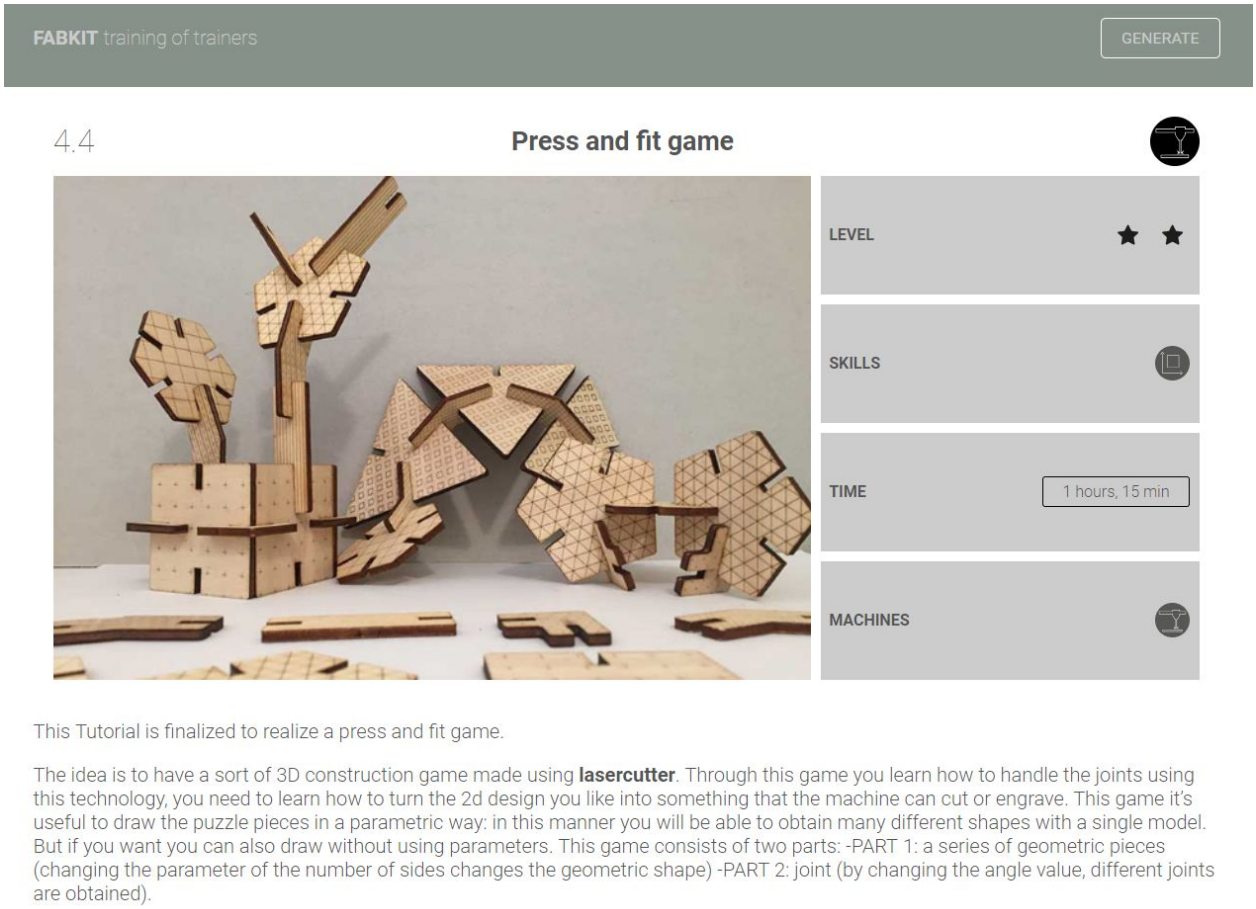


Softwares are usually thought through tutorials, the only passive format is “checklists & cheat sheet”, useful to remember shortcuts and the most common commands.

Templates

The idea to define how to collect the information in a template has been introduced after a preliminary research on the heterogeneity of the educational activities documentation shared online. We have not planned to define what the proper template for all the formats in this phase, but we suggest to define a second round of development that includes the definition of a template per format.
Once the template is available, it can be filled and shared automatically or by hand.
The developer Ludovico Russo, developed the following beta of an online form to collect all the info to create a tutorial: http://fabkit.gitlab.io/generator/
He could be contacted to develop a similar solution for TdH and the online infrastructure to collect and share the contents developed
Here there is an example of a content created using his form, shared on http://fabkit.gitlab.io/

Press and fit game: http://fabkit.gitlab.io/tutorials/2018-06-07-press-and-fit-game/index.html



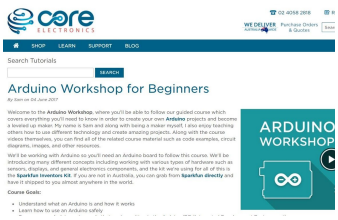
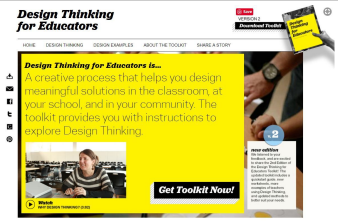
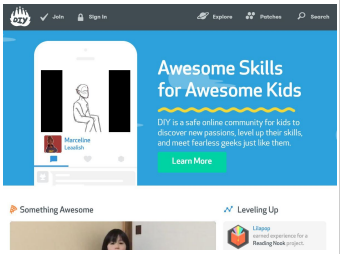
Online platforms

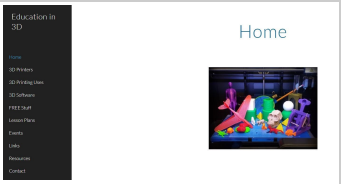
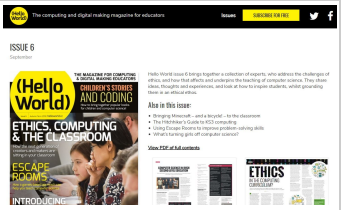
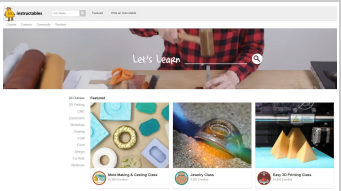
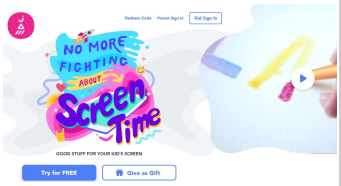
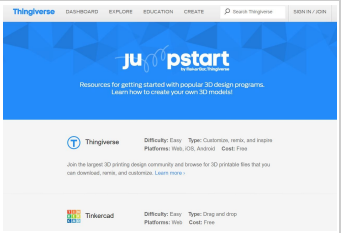
Considering the importance of scaling up quickly the range of possible contents to convert into IN Edu formats, we analysed online platforms that collects educational materials that could be used for the scope.
The parameters used to filter out are:

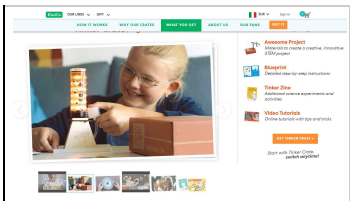
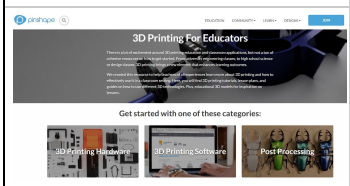
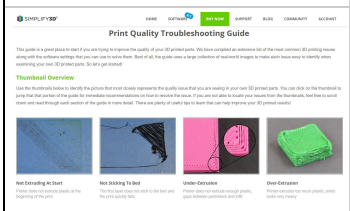
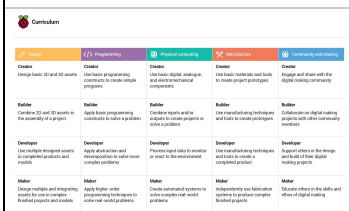
1. **The contents are based on an hands-on approach.** Even if technology is not directly involved, the method is compatible with the educational programs runned in Fab Labs
2. **The contents are documented properly.** Even if a complete, step-by-step, documentation is quite rare, a Fab Lab manager, with a minimum technological background should be able to understand and run an activity based on what is available.
3. **The contents are easily adjustable to TdH Labs.** Even if the contents are based on a not available technology, it should be easily adjustable and reused.

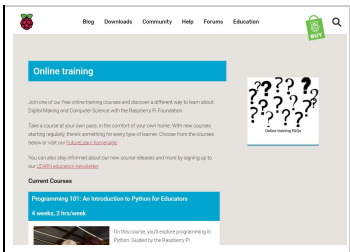
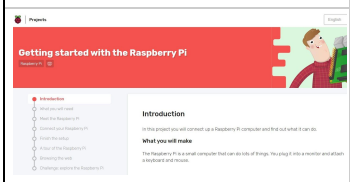
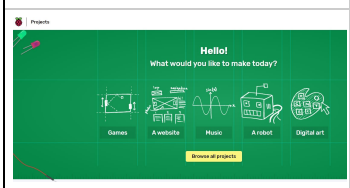
Platforms selected

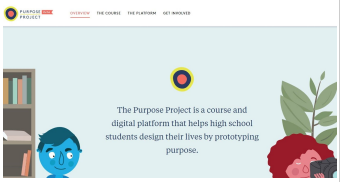
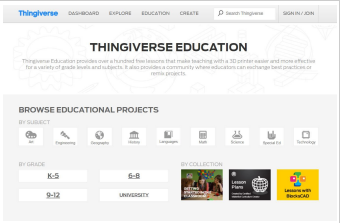
We have mapped **53 solutions** (the results of the form are visible at this link) of these we report the 38 most significant for us through the summary table below, indicating name, link, a small description and a categorization of the content according to the formats described previously.

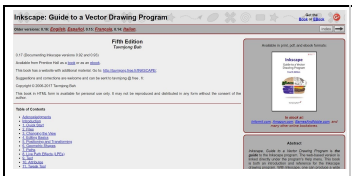
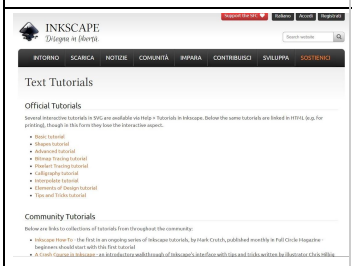
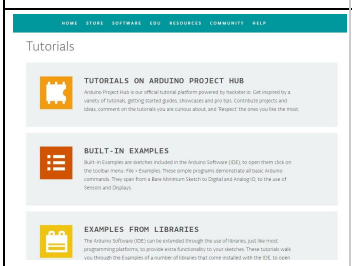
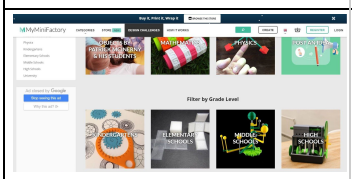
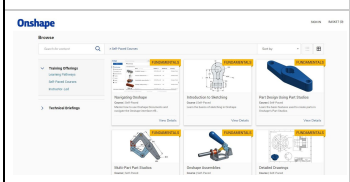
	NAME	DESCRIPTION	AVAILABLE CONTENTS
	Arduino Workshop for Beginners - Core electronics	Video Lesson: Learn how to use an Arduino, program it with Arduino IDE (Integrated Development Environment), understand best practice concepts for programming and prototyping, use a wide variety of hardware and components.	Intro, Cheatsheet
	3D Print School - Blog	Blog for encouraging the use of 3D Printers in the Classroom by sharing examples and good practise.	Tutorial basic
	Design Thinking for Educators Toolkit - Ideo	This toolkit contains the process and methods of design along with the Designer's Workbook, adapted specifically for the context of K-12 education. It offers new ways to be intentional and collaborative when designing, and empowers educators to create impactful solutions.	Part of courses
	Diy by littleBits	DIY is a creative community for kids to learn new skills, share their projects, and meet other kids around the world who share their passions.	Tutorial basic

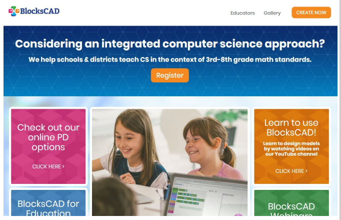
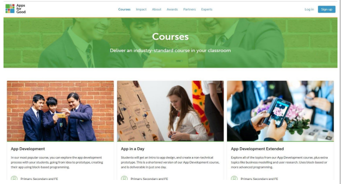
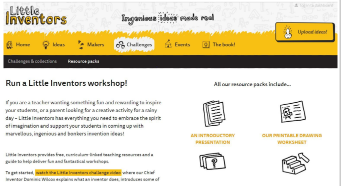
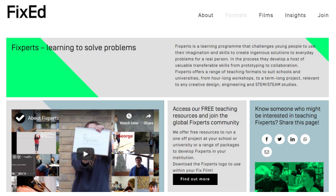
	Education in 3D - Mark Simmons	Site that contains 3D printing material for school: STEM examples, 3D models and video resources.	Tutorial basic
	Hello Word - Webzine	Webzine: Digital making magazine for educators. Hello World issue 6 brings together a collection of experts, who address the challenges of ethics, and how that affects and underpins the teaching of computer science. They share ideas, thoughts and experiences, and look at how to inspire students, whilst grounding them in an ethical ethos.	Part of courses
	Instructables - Classes	"Classes" is a section of the instructables platform. Contains collections of "Instructables": a special format created by the platform for describes step by step tutorials with files and instructions, divided by topics and level of difficulty. The contents for each "class" are like Mooc with a theoretical part and exercises (basic and advanced tutorials). The topics including 3D Printing, CNC, Electronics.	Tutorial basic, Tuturial advanced, Part of courses
	Jam - by littleBits	Little Steam project is a platform like a socialmìnetwork, where kids can develop soft skills Kids watch inspiring videos, do creative projects, and make their own videos on JAM which gives them amazing opportunities to both learn and inspire other kids.	Tutorial basic
	Jumpstart - Makerbot/Thingiverse	Resources for getting started with popular 3D design programs.In particular at this link you can find resources about OpenSCAD: great at making parametric designs. If you want to make models with precise measurements, specific tolerances, moving parts, or enclosed hinges, or ones that use mathematical or procedural information, then OpenSCAD is one of your best free design options.	Intro, Tutorial basic

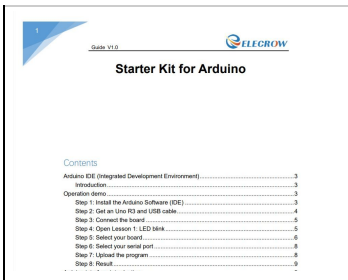
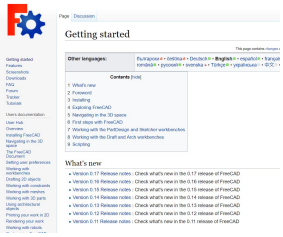
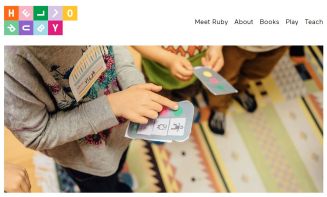
	Kiwico Thinker Crate	Kiwico is a monthly box for hands-on STEM projects. There are different kind of content, for different ages. It's an inspiration for realize ours STEM projects. That's contain: materials to create a creative, detailed step-by-step instructions, additional science experiments and activities, online tutorials with tips and tricks.	Workshop
	Makerbot Educators Guidebook	This book is a synthesis, organized, of the contents on the "Thingiverse Education" platform, redesigned to be more usable and suitable for teachers and educators who for the first time want to try 3D printing in their class. It's composed of different types of content, (introduction to technology, basic and advanced tutorials).	Intro, Cheatsheet, Tutorial basic, Tutorial advanced, Workshop
	Pinshape	We created this resource to help teachers of all experiences learn more about 3D printing and how to effectively use it in a classroom setting. Here, you will find 3D printing tutorials, lesson plans, and guides on how to use different 3D technologies. Plus, educational 3D models for inspiration on lessons.	Intro, Tutorial basic, Tutoriall advanced, Workshop
	Print Quality Troubleshooting Guide	This content is created to help teachers of all experiences learn more about 3D printing and how to effectively use it in a classroom setting. Here, you will find 3D printing tutorials, lesson plans, and guides on how to use different 3D technologies. Plus, educational 3D models for inspiration on lessons.	Cheatsheet, Manual
	Raspberry Pi - Curriculum	At this link you can find a table with a classification of different contents divided by subject and difficulty. Useful to understand from what to start learning Raspberry depending on which output you want to achieve (design, phisical computing etc ..)	Tutorial basic

	On line training for Educators - Raspberry Pi	On this page you can find an introduction to Python for educators. Some of the topics covered are: Teaching Programming in elementary schools, how computers work, prepare for running a Club of code, object-oriented programming in Python: create your own adventure game, teach the physical calculation with Raspberry Pi and Python.	Intro
	Raspberry Pi getting started	On this page you can find lesson plans for educators on the implementation of the Raspberry Pi digital curriculum: it is a basic resource to start with. On the platform you can browse through different lessons and exercises, but you can access printable content.	Intro, Manual
	Raspberry Pi Workshop for Beginners - Core Electronics	At this link you can find a webinar, like a MOOC about Raspberry Pi. You start from the basic contents: Understand what to Raspberry Pi is, setting up your Raspberry Pi, programming With Python, at the end you can find advanced contents like: Get started with IFTTT or control GPIO over the internet	Intro
	Raspberry Pi - Projects	This platform contain hands on exercise, little tutorial for learn basics of Scratch, HTML/CSS, Python, Sonic Pi, and other resources related to Raspberry Pi.	Tutorial basic
	Ready, set, make! Ebook - TCEA	This e-book collects a series of STEM activities to be carried out with the class, not always digital but interesting as a starting point for designing a STEM workshop or a course. the feedback form of the activity seems interesting to us.	Workshop

	Scopes - Fab Foundation	Co-create standards-aligned digital fabrication curriculum for STEM education that reflects open-source values. Connect, discover and share digital fabrication lesson plans with educators all around the world.	Tutorial basic, Tuturial advanced, Workshop
	Stratasys Education	On this platform you can find material for teacher, tutorials, lesson plan about 3D printing in a class. From engaging students, to STEAM career prep, to increasing speed, accuracy, and creativity in your lab.	Intro, Tutorial basic
	Teach 4 Learning - Creative Educator (blog)	This site contains a series of resources and ideas for teachers related to digital tools for use in the classroom. It is not related to the technologies present in the fablabs but it may be interesting to integrate the use of some of these tools in the courses or workshops to document the projects.	Workshop
	The Purpose Project - Ideo	The Purpose Project is a course and digital platform that helps high school students design their lives by prototyping purpose.	Courses, part of courses
	Thingiverse Education	Thingiverse Education provides over a hundred free lessons that make teaching with a 3D printer easier and more effective for a variety of grade levels and subjects. It also provides a community where educators can exchange best practices or remix projects. (Contents, Print Settings, Lesson Plan and Activity, Materials Needed, Skills Learned, Duration of Lesson)	Tutorial basic, Tutorial advanced, Workshop

	Inkscape Guide	This guide can be useful as a basis for using the Inkscape software, it deals with a first approach to the basic commands and an introduction to the software	Intro Tutorial basic
	Inkscape Text Tutorial	On this page you can find a series of official text tutorials for learning Inkscape Software.. There are also many tutorials developed by the community, starting from basic courses to more advanced examples.	Tutorial basic
	Arduino Official Tutorial Page / Project Hub	In the "tutorial" section of the official website of Arduino there's "Arduino Project Hub" platform which contains many tutorials with step by step explanations, divided into categories. It is also possible upload own project. In the same section you can also find the examples included in Arduino Software (IDE).	Intro Tutorial basic
	MyMIniFactory	My Mini Factory is a platform where you can upload and download models for 3D printing. Within the educational area of the site there are several 3d models, divided by category, which can be useful as exercises, or ideas for STEM activities.	Workshop
	Onshape learning center	On this Platform you will find the Learning Center of the OnShape modeling software: the contents are of different format, tutorials, lessons, webinars. Many of the contents are videos, they are almost all free but there are also paid professional packages.	Tutorial Basic Tutorial Advanced

 BlocksCAD Educators Gallery CREATE NOW Considering an integrated computer science approach? We help schools & districts teach CS in the context of 3rd-8th grade math standards. Register Check out our online PD options CLICK HERE › Learn to use BlocksCAD! Learn to design models by watching videos on our YouTube channel CLICK HERE › BlocksCAD for Education BlocksCAD Webinars	[BlockCAD Educators]()	BlocksCAD, is a cloud-based 3D modeling tool that encourages users to learn math, computational thinking and coding concepts through visualization and designing models to be 3D printed. (video tutorial - you tube)	Tutorial Basic Tutorial Advanced
 Apps for Good Courses Impact About Awards Partners Experts Log in Sign up Courses Deliver an industry-standard course in your classroom App Development: In our most popular course, you can explore the app development process with your students, going from idea to prototype, creating their app using block-based programming. Primary, Secondary and FE App in a Day: Students will get an intro to app design, and create a non-technical prototype. This is a shortened version of our App Development course, and is deliverable in just one day. Primary, Secondary and FE App Development Extended: Explore all of the topics from our App Development course, plus extra topics like business modelling and user research. Uses block-based or more advanced programming. Primary, Secondary and FE	[Apps For Good]()	On this site you can find resources related to app development, Internet of Things and Machine Learning. An on-line workbook for students is provided for each topic.The course includes a part of exercises to be carried out individually or in groups.	Workshop Part of course
 Little Inventors Ingenious ideas made real log in to dashboard Upload ideas! Home Ideas Makers Challenges Events The book! Challenges & collections Resource packs Run a Little Inventors workshop! If you are a teacher wanting something fun and rewarding to inspire your students, or a parent looking for a creative activity for a rainy day – Little Inventors has everything you need to embrace the spirit of imagination and support your students in coming up with marvellous, ingenious and bonkers invention ideas! Little Inventors provides free, curriculum-linked teaching resources and a guide to help deliver fun and fantastical workshops. To get started, watch the Little Inventors challenge video where our Chief Inventor Dominic Wilcox explains what an inventor does, introduces some of All our resource packs include... AN INTRODUCTORY PRESENTATION OUR PRINTABLE DRAWING WORKSHEET	[Little Inventors]()	Focusing on the invention of social purposes, Little Inventors supports the great ideas that can come from small people. Results are obtained such as troubleshooting, creativity, community commitment, links with industry / maker experts.It works through challenges, events, and online resources.	Workshop Part of course
 FixEd About Formats Films Insights Join Fixperts – learning to solve problems Fixperts is a learning programme that challenges young people to use their imagination and skills to create ingenious solutions to everyday problems for a real person. In the process they develop a host of valuable transferable skills from prototyping to collaboration. Fixperts offers a range of teaching formats to suit schools and universities, from hour-long workshops, to a term-long project, relevant to any creative design, engineering and STEM/STEAM studies. About Fixperts Watch later Share Access our FREE teaching resources and join the global Fixperts community We offer free resources to run a one off project at your school or university or a range of packages to develop Fixperts in your institution. Download the Fixperts logo to use within your Fix Film! Find out more Know someone who might be interested in teaching Fixperts? Share this page!	[FixEd]()	Learning programme that challenges young people to use their imagination and skills to create ingenious solutions to everyday problems, developing a host of transferable skills from prototyping to collaboration. Fixperts offers a range of teaching formats to suit schools and universities, from hour-long workshops, to a term-long project, relevant to any creative design, engineering and STEM/STEAM studies.	
 flipped classroom repository raccolta di unità di apprendimento liberamente condivise dagli insegnanti apprendi come realizzare unità di apprendimento flipped classroom per i tuoi studenti VEDI Carica le tue unità di apprendimento: Puoi pubblicare le tue unità di apprendimento per condividerle con altri docenti. Carica Cerca tra le unità di apprendimento: Decine di insegnanti hanno già condiviso le loro unità di apprendimento. Cerca Pubblicare l'unità di apprendimento: Ecco un esempio a cui puoi ispirarti per costruire l'unità di apprendimento. Vedi Finalità del sito e politiche di pubblicazione: Chi siamo, come funziona e quali sono gli obiettivi di questo sito. Leggi	[Flipped Classroom Repository]()	Flipped classroom repository is a web collection of learning units freely shared by teachers who use or want to start using the "flipped classroom" model in their classes. Allows you to search from the class or subject of teaching.	Part of courses

	Starter Kit for Arduino by Elecrow	Small Arduino manual by Elecrow consisting of an introductory part (Connect the board, interface introduction, hardware introduction, ect) and thirty progressive difficulty tutorials.	Intro Tutorial base, Tutorial advanced
	ShopBot: Using Digital Fabrication in Your Classroom	These ready-to-cut projects will get your students excited about the possibilities of making things. Along the way they'll be absorbing the principles of STEM and other subjects that you want to teach. They're road-tested by educators like you, ready for use with your students.	Tutorial advanced
	FreeCAD Documentation	Mini "wiki" platform, training center for the FreeCad free modeling software. It contains a guide, exercises, tutorials and many other basic and advanced contents to learn how to use the software.* **many of the platform's contents are available in several languages*	
	Hello Ruby	Hello Ruby is the world's most whimsical way to learn about computers, technology and programming. The story started with a book, and now Ruby continues her adventures in exercises, games and apps. It's suited for kids age 5 years and older (but even adults might learn something new).** ***The Book has been published in over 20+ languages*	

Mapping of courses

Mapping existing solutions done in fablabs seemed to be the most reasonable approach. We encountered some obstacles that slowed down the process:

1. Fab Labs managers are quite busy, they don't always have time to fill forms\prepare materials
2. Even if education and training is one of the most common activity for a Fab Lab, it's rarely focussed on humanitarian topics\contexts
3. Similar areas, such as NEET, or fragile portions of the population, are approached with different objectives and methods
4. Interesting activities done, that could be inspiring, are not always documented
5. If documented, they are not necessary in english
6. If in english it's usually a document describing *what* the activity is, eventually *why*, rarely *how*

Because of this, we decided to map also online repositories of educational activities, designed to support the sharing of these contents.
We started to collect feedback using a form described later on, but it is probably going to take more time and it would be very helpful an endorsement by the Fab Foundation.
So far we collected a very limited number of answers, so we suggest to move this part of the research to a second phase.

Form used for mapping fab labs courses

We prepared a form to collect the basic info about an interesting educational activities done in a Fab Lab. The objective was to be able to:

1. Define objectives and goals of the activity
2. List the technologies required
3. Organize contents in the possible formats
4. Understand better the structure
    a. Duration
    b. number of students
    c. Age
    d. Complexity
    e. ...
5. Have a reference to talk to (if TdH decides to replicate or modify the activity)

Here the link to the form.

5 Chosen solutions

We suggest to start from the following solutions:

1. **Makerbot Educator Book and 3D printing**

   Considering the need to be immediately operative in the new TdH Labs in Ukraine, we selected a complete set of contents for 3D printing. Some of these are based on the most complete and well structured content available online: the Makerbot Educator Book. These contents should be enough to develop a lot of activities with different duration and targets.

2. **Arduino Starter Kit and Arduino**

   Considering the need to be immediately operative in the new TdH Labs in Ukraine, we selected a complete set of contents for Arduino. The Arduino Starter Kit is going to be available in the labs, and it is very well done, both because of the progressiveness of the activities, and the documentation supplied. Other activities have been selected to integrate the gaps, in particular a quite advanced workshop that mix 3D printing and Arduino.

3. **Emosilla**

   Even if it could be necessary to integrate the documentation, it is one of the most interesting activity to be done with a CNC machine. It has been widely tested in south america and it has been replicated and tested a lot of times. It fits well both the level of complexity and the context of TdH Labs. it could also be used to produce some of the furniture for the kids involved

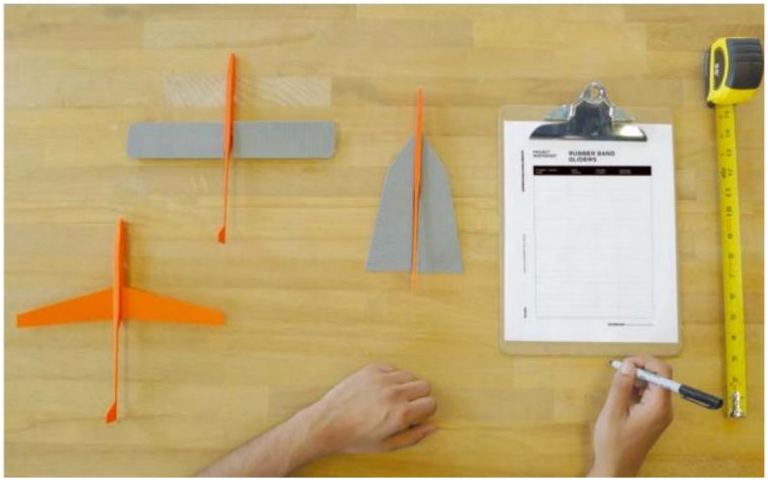
4. **Dotti**

   Dotti is one of the few, very well documented, activities based on the embroidery machine. It has been developed by Laura Cipriani and tested in Opendot as well. The activity was designed to be done with children with physical and cognitive limitation, but it has been done with other targets as well.

5. **Autodesk Design Academy**

   Autodesk have a wide range of material to learn how to use Fusion 360, one of the most complete software, available for free for non-commercial uses. We choose Fusion 360 also because of the range of examples and application: it is quite easy to find both simple applications and very advanced ones. Because of this it is probably the most versatile available at the moment.

01 MAKERBOT Educator Book and 3D PRINTING



CONTEST / ORGANIZATION
Thingiverse education, Makerbot

NUMBER OF PARTICIPANTS
15-30

AGE AND LEVEL
GRADE K-5, 6-8, 9-12

TIME
From 3–4 Class Periods to 10—12 Class Periods

TOPIC
3D printing
STEM

DESCRIPTION

This book is a synthesis, organized, of the contents on the "Thingiverse Education" platform, redesigned to be more usable and suitable for teachers and educators who for the first time want to try 3D printing in their class.
It's composed of different types of content, (introduction to technology, basic and advanced tutorials) it's a complete document, focusing on the MakerBot printers but also useful for those using other printers.
This guide includes a crash course on 3D printing and 3D design for educators, 9 classroom-ready 3D printing lesson plans, tips, tricks, and best practices from 3D printing and stem educators.

Makerbot Educator Book content:

- **Part 1:** The basics on how 3D printers work and how to use them, including a crash course on 3D design.
- **Part 2:** Nine teacher-tested 3D printing lesson plans to integrate the technology into the classroom, bringing STEM and project based learning to a variety of subjects and grades.
- **Part 3:** Next steps for building your own lesson plans and going further with prints.

COMPLETE DOCUMENTATION

http://pages.makerbot.com/rs/444-ZTM-866/images/MakerBot_Educators_Guidebook_vf2.pdf

A complete set of formats on the specific case of 3D Printing:

To integrate the documentation on 3D printing to the Makerbot Educator Book, which can be useful to formulate courses within Fablab, we have collected a series of contents. Below find a series of links corresponding to the previously described formats.

Intro:

- http://pages.makerbot.com/rs/444-ZTM-866/images/MakerBot_Educators_Guidebook_vf2.pdf

  (pag. 10 -> pag.28)

Cheatsheet:

- https://core-electronics.com.au/media/wysiwyg/tutorials/aidan/3dP/practical-printing-poster-png.png
- https://steemitimages.com/p/62PdCouTvNPCrqBxU3fPZCSSbPckTWZJwBQbuxrF2csspjrdov29N2jS5KRpiuQEyxTGpBC7ubKt6iNiGWGCk1E8oXUXo2NEAATchNZkgZhJPWf
- https://www.simplify3d.com/support/print-quality-troubleshooting/

Checklist:

- https://ultimaker.com/download/18439/Checklist.pdf

Manual:

- https://manual.prusa3d.com/c/English_manuals

Tutorial - basic:

- https://www.instructables.com/class/Easy-3D-Printing/
- https://www.instructables.com/class/Beginner-3D-Printing-Class/

Tutorial - advanced:

- https://www.instructables.com/class/Intermediate-3D-Printing-Class/
- https://www.instructables.com/class/Advanced-3D-Printing-Class/

Workshop:

- https://www.youtube.com/watch?v=4a9aTn8atQU
- https://wikifactory.com/+OttoDIY/rover#readme
- (https://github.com/davidhrbaty/ArduBot)
- http://pages.makerbot.com/rs/444-ZTM-866/images/MakerBot_Educators_Guidebook_vf2.pdf

(pag.128 -> pag. 139)

The workshop selected is the the same linked in “3D printing and Makerbot educator book”. We selected an example that could have two technologies required, a quite common condition in the workshop format.

Course (TO BE DEFINED): a course must be designed integrating the other formats, with a pedagogic goal in mind. Considering the complexity, we suggest to focus on courses later on.

02 Arduino Starter Kit and ARDUINO

CONTEST / ORGANIZATION
Arduino

NUMBER OF PARTICIPANTS
1-4

AGE AND LEVEL
From 8 years old

TIME
1-2 hours for exercise

TOPIC
Electronics
Arduino

DESCRIPTION

The Starter Kit walks you through the basics of using the Arduino in a hands-on way. You'll learn through building several creative projects. The kit includes a selection of the most common and useful electronic components with a book of 15 projects. Starting the basics of electronics, to more complex projects, the kit will help you control the physical world with sensor and actuators.

COMPLETE DOCUMENTATION

- https://www.youtube.com/playlist?list=PLT6rF_I5kknPf2qlVFlvH47qHvqvzkknd (Video Tutorial)

A complete set of formats on the specific case of Arduino:

Intro:

- 01 GET TO KNOW YOUR TOOLS an introduction to the basics (from “Arduino Starter Kit”)
- https://core-electronics.com.au/tutorials/arduino-workshop-for-beginners.html

Cheatsheet:

- https://i2.wp.com/tinkrlearnr.com/wp-content/uploads/2017/11/arduino_cheatsheet_poster_blue_green.jpg
- https://github.com/liffiton/Arduino-Cheat-Sheet/blob/master/Arduino%20Cheat%20Sheet.pdf

Manual:

Manuals are only for technologies you have to maintain or assemble. Considering we are not planning to build our own arduinos, there is no manual.

Tutorial - basic:

- 02 SPACESHIP INTERFACE design the control panel for your starship (from "Arduino Starter Kit")

Tutorial - advanced:

- 03 LOVE-O-METER measure how hot-blooded you are
- 04 COLOR MIXING LAMP produce any color with a lamp that uses light as an input
- 05 MOOD CUE clue people in to how you're doing
- 06 LIGHT THEREMIN create a musical instrument you play by waving your hands
- 07 KEYBOARD INSTRUMENT play music and make some noise with this keyboard
- 08 DIGITAL HOURGLASS a light-up hourglass that can stop you from working too much
- 09 MOTORIZED PINWHEEL a colored wheel that will make your head spin
- 10 ZOETROPE create a mechanical animation you can play forward or reverse
- 11 CRYSTAL BALL a mystical tour to answer all your tough questions
- 12 KNOCK LOCK tap out the secret code to open the door
- 13 TOUCHY-FEEL LAMP a lamp that responds to your touch
- 14 TWEAK THE ARDUINO LOGO control your personal computer from your Arduino
- 15 HACKING BUTTONS create a master control for all your devices!
- (from Arduino Starter Kit)

Workshop:

- https://www.youtube.com/watch?v=4a9aTn8atQU
- (https://github.com/davidhrbaty/ArduBot) (more advanced)
- https://wikifactory.com/+OttoDIY/rover#readme
- https://www.maffucci.it/2019/01/20/edurobot-asl-alternanza-scuola-lavoro-manuale-di-costruzione-2-3/?fbclid=IwAR37TJJQxQX5JDdzNyxJGinW67K-wIkxayjHBAsa82gvxRa_p9L1WkyCIOA (to be translated)

The workshop selected is the the same linked in "Arduino & Arduino starter kit". We selected an example that could have two technologies required, a quite common condition in the workshop format.

Course (TO BE DEFINED): a course must be designed integrating the other formats, with a pedagogic goal in mind. Considering the complexity, we suggest to focus on courses later on.

03**EMOsilla**

CONTEST / ORGANIZATION
FabLab Ciudad de México, Fab Lat Kids

NUMBER OF PARTICIPANTS
20

AGE AND LEVEL
4-10 years old

TIME
3 hours

TOPIC
CNC milling machine (lasercutter), 2D drawing

DESCRIPTION

The Emosilla Workshop has the goal to make the kids aware of their emotions and help them capture them on a chair that they fabricate, customize and take home. It also intends to promote cultural exchange within Latin America, where it was conceived, and to the rest of the world. Basic concepts of digital fabrication are introduced to the kids. They participate in the design of their own chair and fabricate it using the Milling machine and Laser cutter. In the next step they assemble it with a press-fit construction process and paint it. During the workshop, we connect to other fab labs around the world which are doing the Emosilla workshop simultaneously.

The workshop also researches about education and digital fabrication for Latin American kids. It is based on a methodological perspective that includes local technological adaptations, data collection and online knowledge exchange among Fab Labs.

COMPLETE DOCUMENTATION

- http://emosilla00.wixsite.com/emosilla/about-us (about EMOsilla)
- http://docs.wixstatic.com/ugd/383e93_cc157f2c6a2f4e0cb87020699954dcfc.pdf (digital drawing)
- http://docs.wixstatic.com/ugd/383e93_f79ad36be6434beaa874d81fd057a28d.pdf (template for print)
- https://issuu.com/fablatkids/docs/fablatkids_dossier_2016b (Dossier of Fablat-kids activities)

04**DOTTI PUPPET**

CONTEST / ORGANIZATION
Unico, Opendot + TOG

NUMBER OF PARTICIPANTS
10

AGE AND LEVEL
6-10 years old

TIME
From 4 to 8 hours

TOPIC
CNC Embroidery
2D drawing

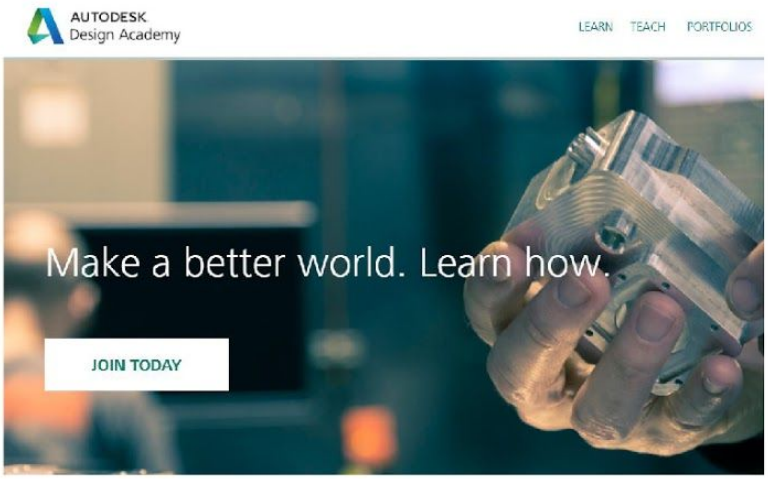
DESCRIPTION

The idea behind this process is that any handmade drawings can become a puppet ... by magic!
Indeed the steps to make a Dotti puppet are: Digitizing drawing, making the embroidery file and machining.
The workshop is usually proposed to small children (4-8 years) who use wooden or cardboard shapes to draw their puppet on a sheet choosing eyes, mouth etc. This allows you to guide the drawing with a story (draw your superhero) or make the child reflect on themes such as emotions or relationships (alone or with a parent). Usually the children come back after a week and find the finished puppet (they do not deal with manufacturing). But with older kids or adults it can become an advanced tutorial to learn how to digitizing drawing, making the embroidery file and use CNC embroidery machine.
With the same method you can make other objects starting from the design made by children (patches, personalization bags, pillowcases, ect). The drawing can also be done using a 2D drawing software such as Inkscape: in this way, for the older kids, a workshop can be created using 2d software and numerical control embroiderer.

COMPLETE DOCUMENTATION

- https://www.bottegadeidotti.com/ (Official Website)
- http://fab.academany.org/2018/labs/fablabopendot/students/laura-cipriani/assignment/week017.html (Fab Academy Documentation)
- http://fab.academany.org/2018/labs/fablabopendot/students/federica-selleri/#list-item-15 (Fab Academy Documentation)
- http://fab.academany.org/2018/labs/fablabopendot/students/massimiliano-dangelo/exercise16.html (Fab Academy Documentation)

05AUTODESK Design Academy



CONTEST / ORGANIZATION
Autodesk

NUMBER OF PARTICIPANTS
15 max

AGE AND LEVEL
From 12 years old

TIME
-

TOPIC
3D modelling
Fusion 360

DESCRIPTION

Autodesk Design Academy helps educators introduce students to the world of design with free, hands-on supplementary projects and course materials.
This platform brings together a series of free content, provided by Autodesk, to support the use of modeling software.The contents are different also based on the software we want to use. We recommend this platform as a basis for learning how to use the "Fusion 360" software.
The contents present are divided into: Course, Webinar and Tutorial: they are mainly based on video-lessons and step by step exercises.

COMPLETE DOCUMENTATION

- https://academy.autodesk.com/software/fusion-360 (Product tutorial: Video training Fusion 360)
- https://academy.autodesk.com/inspiration/webinars (Webinars)
- https://academy.autodesk.com/product-how-to (Other Autodesk software tutorial)