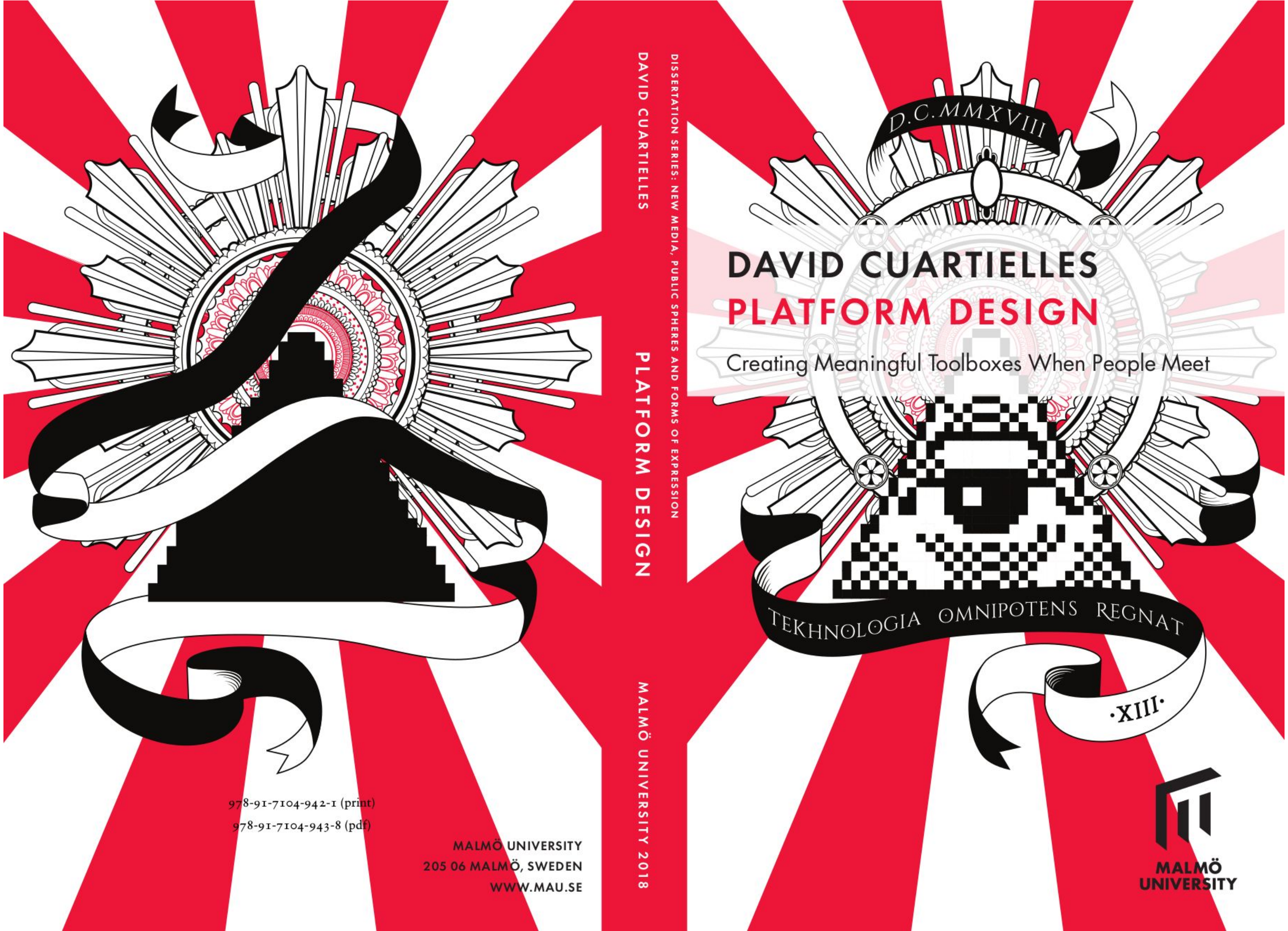
MALMÖ UNIVERSITY

ARDUINO™

Different pedagogical models using tech

Case of STEAM Programs Using Arduino


978-91-7104-942-1 (print)
978-91-7104-943-8 (pdf)
MALMÖ UNIVERSITY
205 06 MALMÖ, SWEDEN
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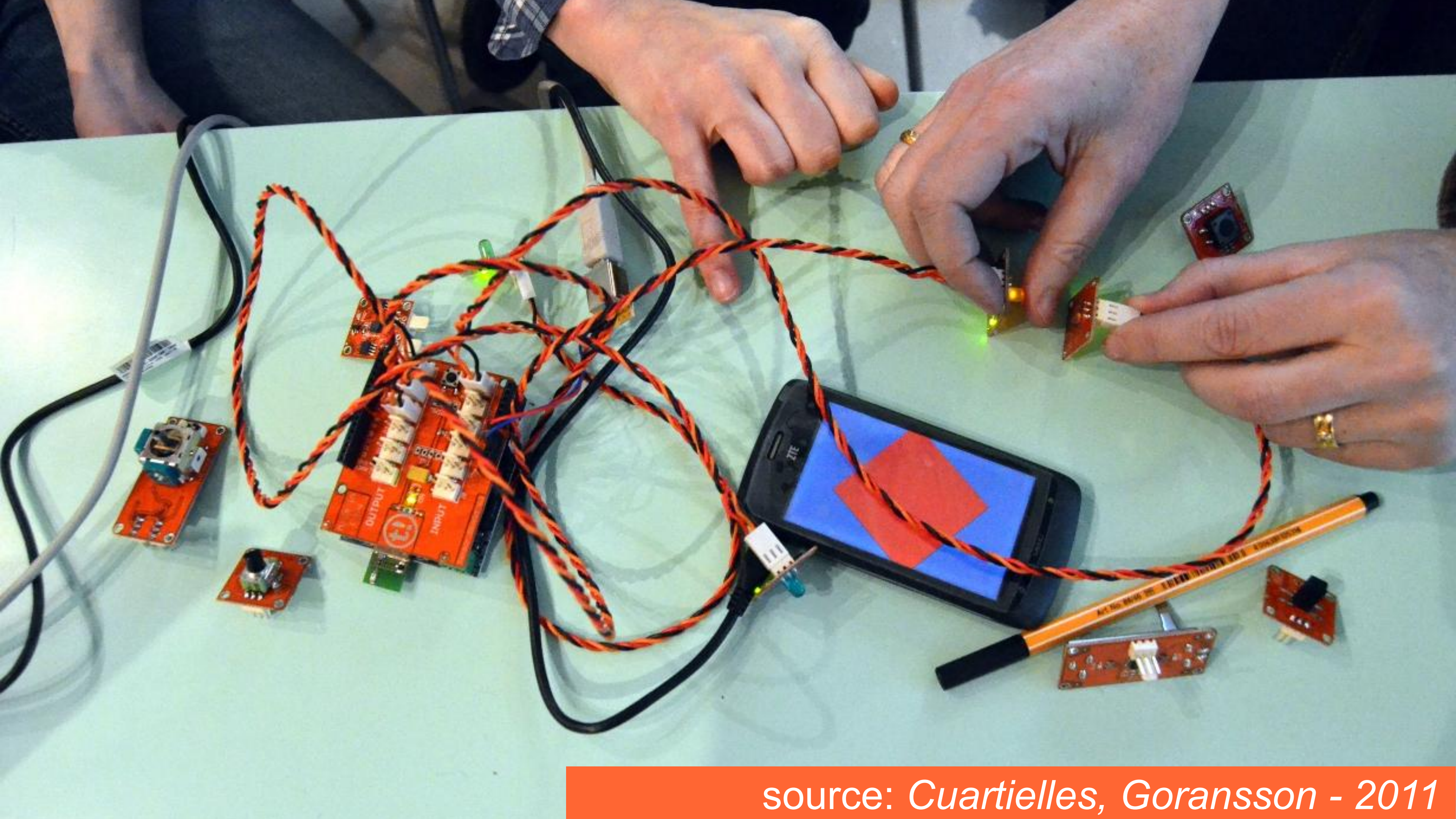
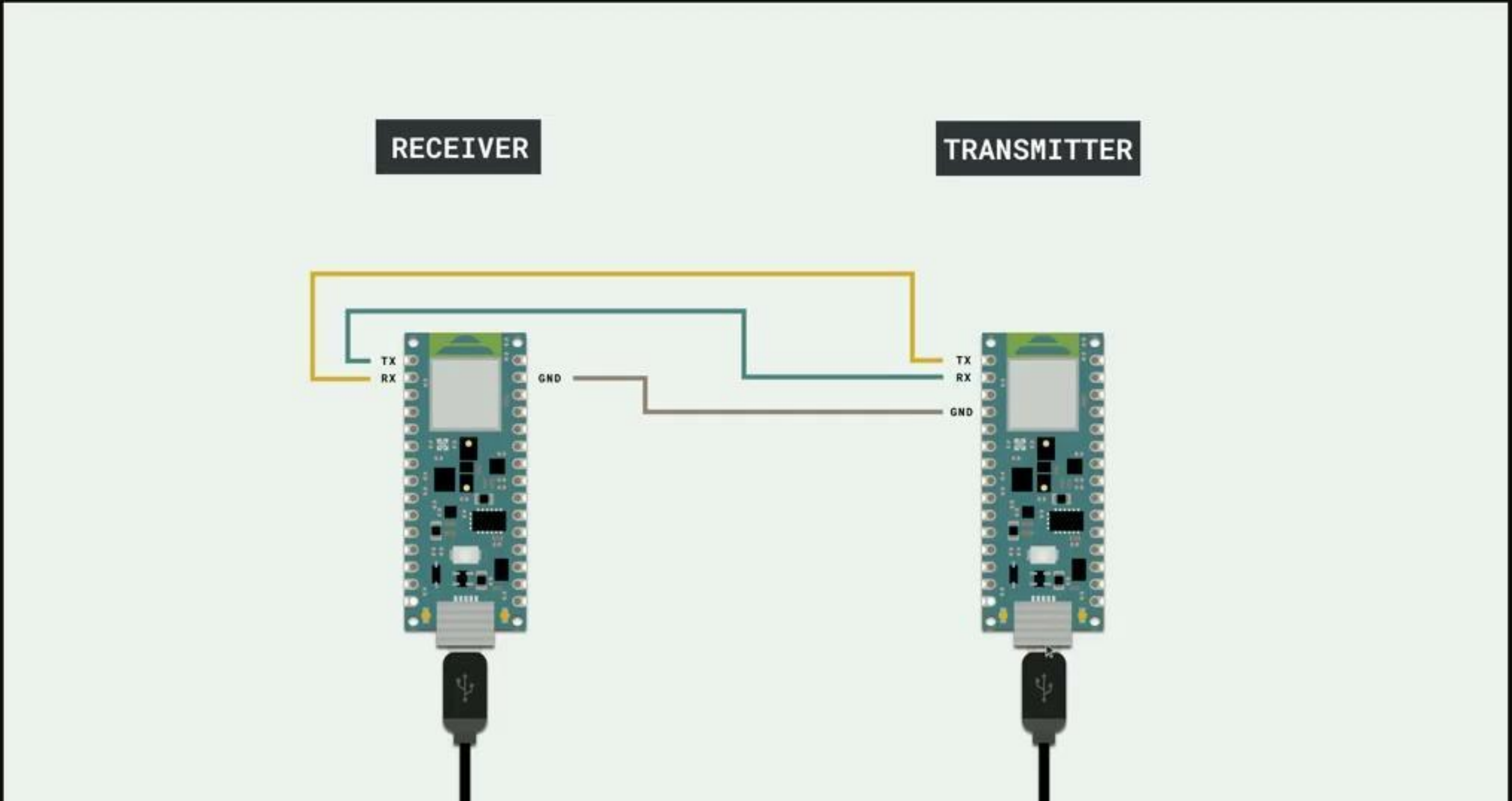
DAVID CUARTIELLES
DISSERTATION SERIES: NEW MEDIA, PUBLIC SPHERES AND FORMS OF EXPRESSION
PLATFORM DESIGN
MALMÖ UNIVERSITY 2018
D.C.MMXVIII
DAVID CUARTIELLES
PLATFORM DESIGN
Creating Meaningful Toolboxes When People Meet
TEKHNOLOGIA OMNIPOTENS REGNAT
·XIII·
MALMÖ
UNIVERSITY

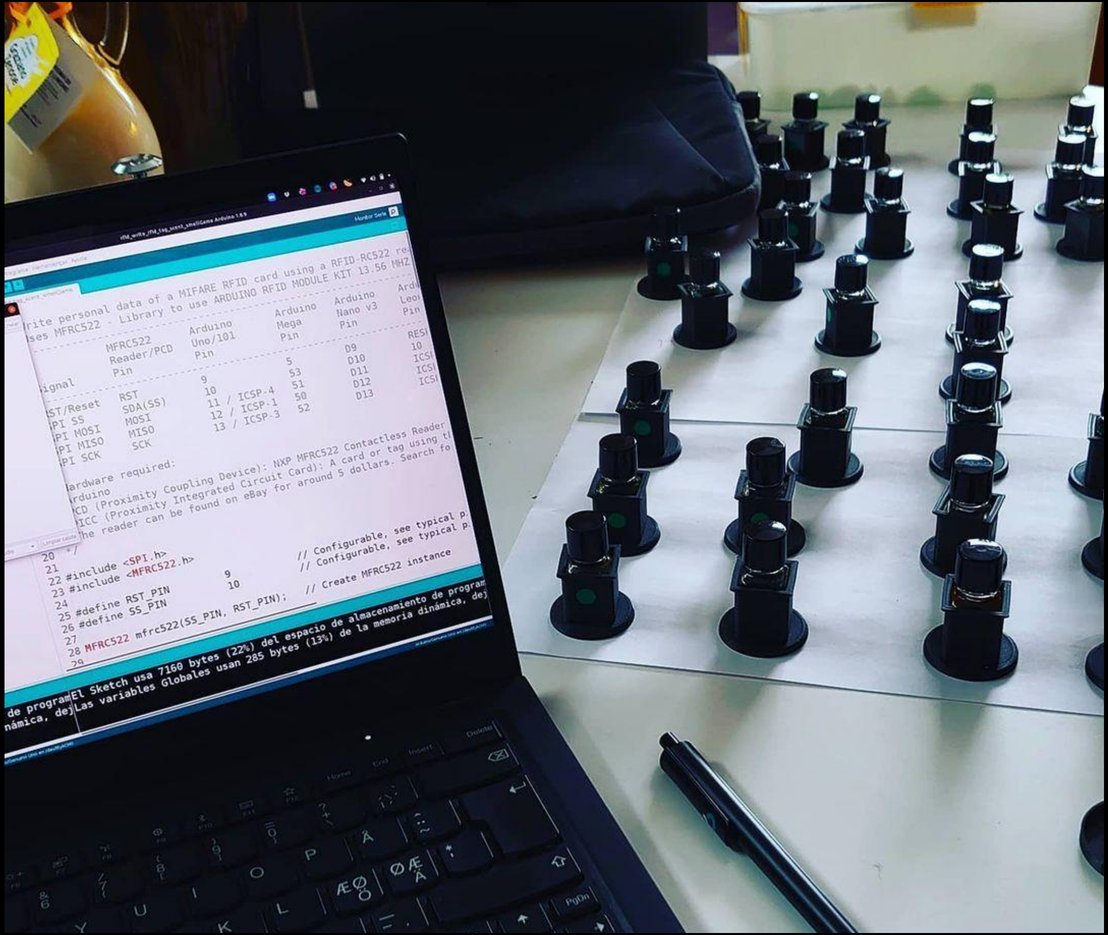

DEVUAN
LG

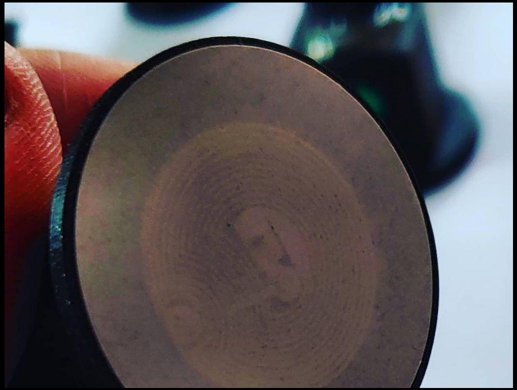


source: *Cuartielles, Goransson - 2011*

docs.arduino.cc/static/64f28a1d9608cda2bae40bb63a61d2bf/29114/nano33BS_12_circuit.png




Hardware required:
#include <SPI.h>
#include <MFRC522.h>
#define RST_PIN 9
#define SS_PIN 10
MFRC522 mfrc522(SS_PIN, RST_PIN);
// Create MFRC522 instance
El Sketch usa 7160 bytes (22%) del espacio de almacenamiento de program
Las variables Globales usan 285 bytes (13%) de la memoria dinámica, dej



source: *kylebean.co.uk*

IxD is a discipline looking at the interaction between [non] humans by means of digital artifacts [products and services].

IxD is well-established

- There is both professional and academic development possibilities when taking the IDM.
- All IT companies hire interaction designers.
- More and more product-centric companies incorporate IxD.
- There is plenty of academic literature in the field.
- The discipline is linked to others such as psychology, engineering, sociology, product design, fine arts, etc.

IxD @MaU

- Programme existing since 1998.
- Exists both at BSc. / MSc. / PhD. levels.
- Alumni at all relevant sectors of the industry, but also within many of the main academic institutions world-wide.

In the meantime I got my stainless steel coffee pot. It was truly beautiful, but using it at home revealed new aspects. It turned out not to be "drip free", however more important, the suspended tilting lid which opened and closed by the motion of pouring was smart, but it could not keep the coffee warm for more than an hour. That was a disappointing experience, when expecting to have a hot cup of coffee on an evening working late. The beautiful stainless cylinder together with the tilting lid was also the source of another problem. The relation between the base and the height of the steel cylinder made it rather unstable and easy to tilt, and then the tilting lid opened. With small children around my beautiful coffee pot became a dangerous trap, at least during the first hour when the coffee still was hot. So my beautiful stainless steel cylinder ended up in the closet, and the only time I use it now is when I tell this story to my students. I still, however, find Eric Magnussen's coffee pot beautiful, but now with reservations. I do no longer find the design exemplary, at least I do not find it appropriate in the context of family life with small children or as a container for hot coffee to keep you awake when working late. Appropriateness, I have now learned is a more important aesthetic category than beauty, and a "pretty interface" is only so in an appropriate context.

Ehn, P. (1997). Quality-in-Use - educating the reflective designer. *Ergonomie'97*.

But this talk is about …

… pedagogical models (and reflections)

- Different ways of approaching technical materials in class.
- Mixing technology with other materials.
- Maximising outreach.
- Thinking about limitations.

People put platforms to use to learn and create things.

The same way we were teaching, other teachers decided to use this platform for STEAM teaching.

STEAM: Science Technology, Engineering, Arts, and Math

STEAM has taken off.

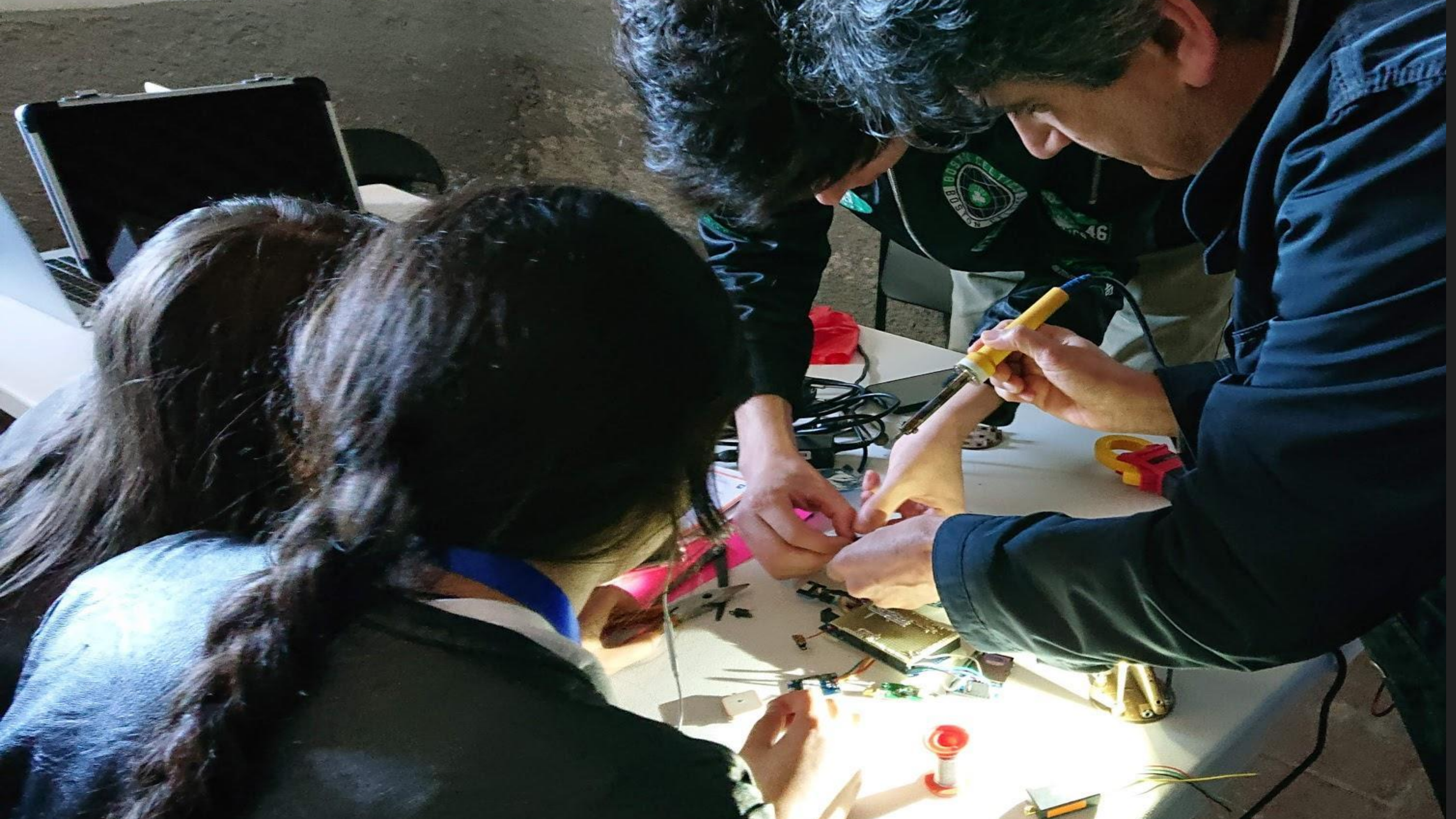
- Many public institutions in the field of education are using the so-called STEAM activities as a way to inspire the younger generations into pursuing science or technical studies.
- STEAM includes arts & crafts, creative technology, robotics, 3D printing, web programming, etc.
- Associated with it, pedagogical approaches such as PBL, constructionism, etc.

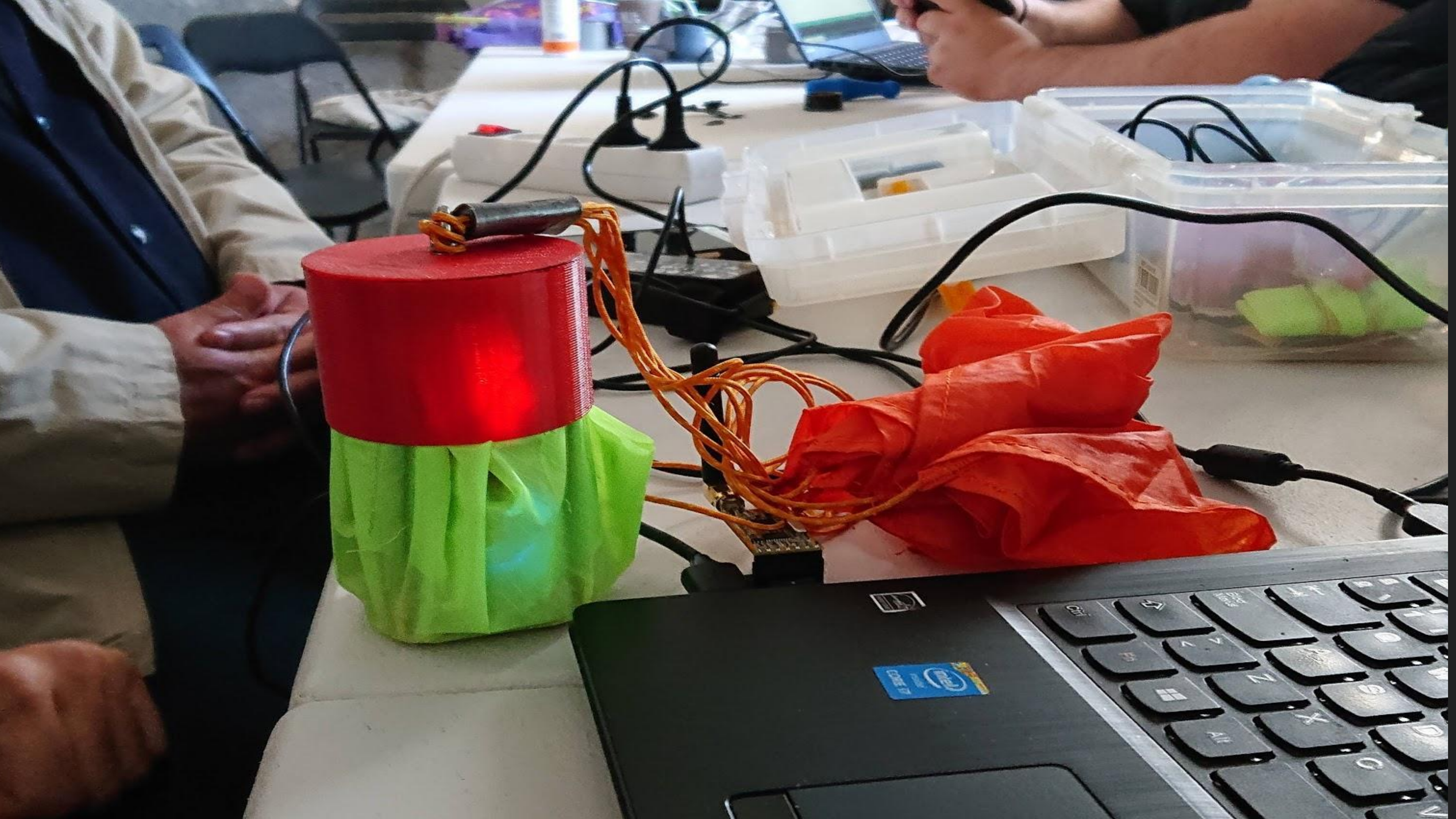
STEAM’s academic references.

- If you want to know more, you should read about Constructionism by Pappert, Resnick and others.
- You should also look at Freire and his theories around the pedagogy of the oppressed.
- Furthermore, you might want to explore aspects of group work (i.e. Social Constructivism), collaboration vs. cooperation, etc.

Case # 1:
IBERCIVIS Foundation,
Spain


WE CAME IN PEACE FOR ALL MANKIND
A recorded history of space exploration and the triumph of the lunar landing
STEREO
DECCA RECORDS





Estación de tierra - GrecoSat II
Puerto SERIE
COM5
STOP
Datos GPS
HORA: 11:31:49
FECHA: 040519
LAT: 41.752735°
LON: -0.892613°
ALT: 288.00 m
VELhor: 0.58 m/s
RUMBO: 323.25°
SAT: 9
VELvert: -0.1 m/s
Altitud Barométrica
Altitud m
318.14
Batería
Voltaje V
7.59
GrecoSat II
Estados
BALIZA
VIDEO
UMBRAL
ESCUDO
Comandos de radio
ABRE ESCUDO
CIERRA ESCUDO
PARACAIDAS
VIDEO
BALIZA
RESET
Acelerómetro
AX
AY
AZ
-0.28
-0.99
1.65
Magnitudes físicas
60
21.99
-5
1100
978.26
850
P hPa
100
32.18
0
Hum %


DEXTER


SPACE
COFFEEBYEV2

Format

Problem definition

Call for applications

Team selection

Technical introduction

Project building

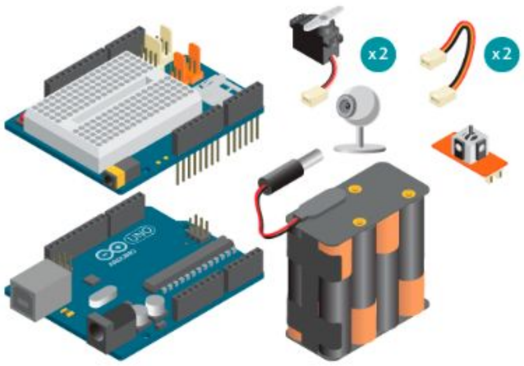
Launch

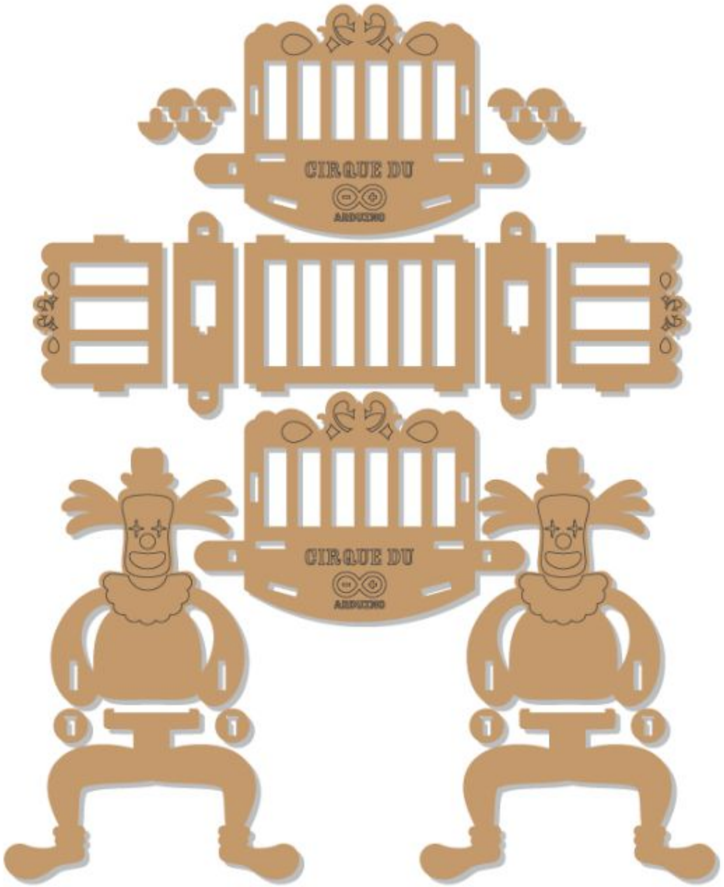
Report

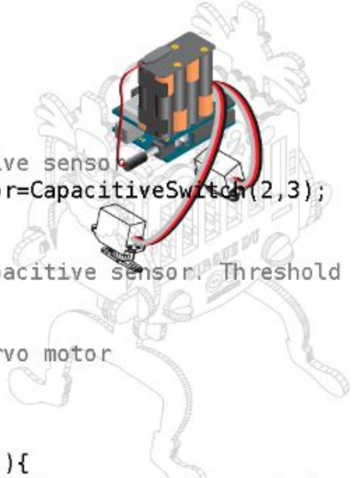
Main characteristics

- Informal education (some schools manage to bring it in)
- Off-the-shelf components, each team different
- Limited group size
- No theoretical component (there is, but it falls on the schools)
- Project Based Learning
- Complex logistics
- Duration: months, variable

Case # 2: Creative Technologies, Spain



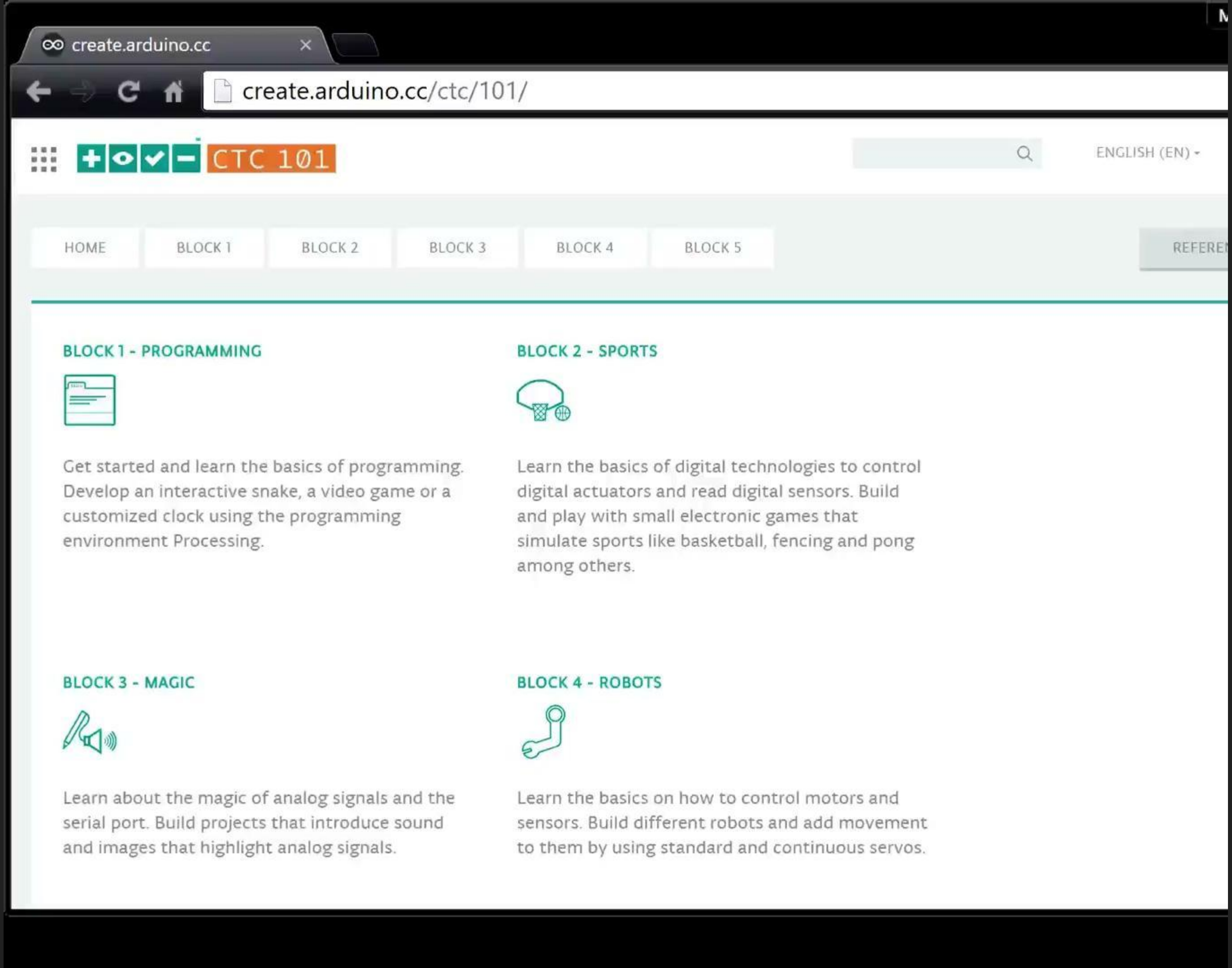




```
//Declare the capacitive sensor
CapacitiveSwitch sensor=CapacitiveSwitch(2,3);

void setup(){
  //initialize the capacitive sensor. Threshold is 400
  sensor.config(400);

  //initialize the servo motor
  pull.attach(9);
}
void loop(){
  if(sensor.getState()){
        //If the capacitive sensor is touched, pull the st
    pull.write(0);
```


create.arduino.cc
create.arduino.cc/ctc/101/
CTC 101
ENGLISH (EN)
HOME
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
BLOCK 5
BLOCK 1 - PROGRAMMING
Get started and learn the basics of programming. Develop an interactive snake, a video game or a customized clock using the programming environment Processing.
BLOCK 2 - SPORTS
Learn the basics of digital technologies to control digital actuators and read digital sensors. Build and play with small electronic games that simulate sports like basketball, fencing and pong among others.
BLOCK 3 - MAGIC
Learn about the magic of analog signals and the serial port. Build projects that introduce sound and images that highlight analog signals.
BLOCK 4 - ROBOTS
Learn the basics on how to control motors and sensors. Build different robots and add movement to them by using standard and continuous servos.


RAW FOOTAGE


RAW FOOTAGE

Format

Selection of schools

1 week teacher course

8 weeks / 4 areas of work

- 2 weeks: Processing
- 2 weeks: Sensors
- 2 weeks: Actuators
- 2 weeks: Comms.

10 weeks project building

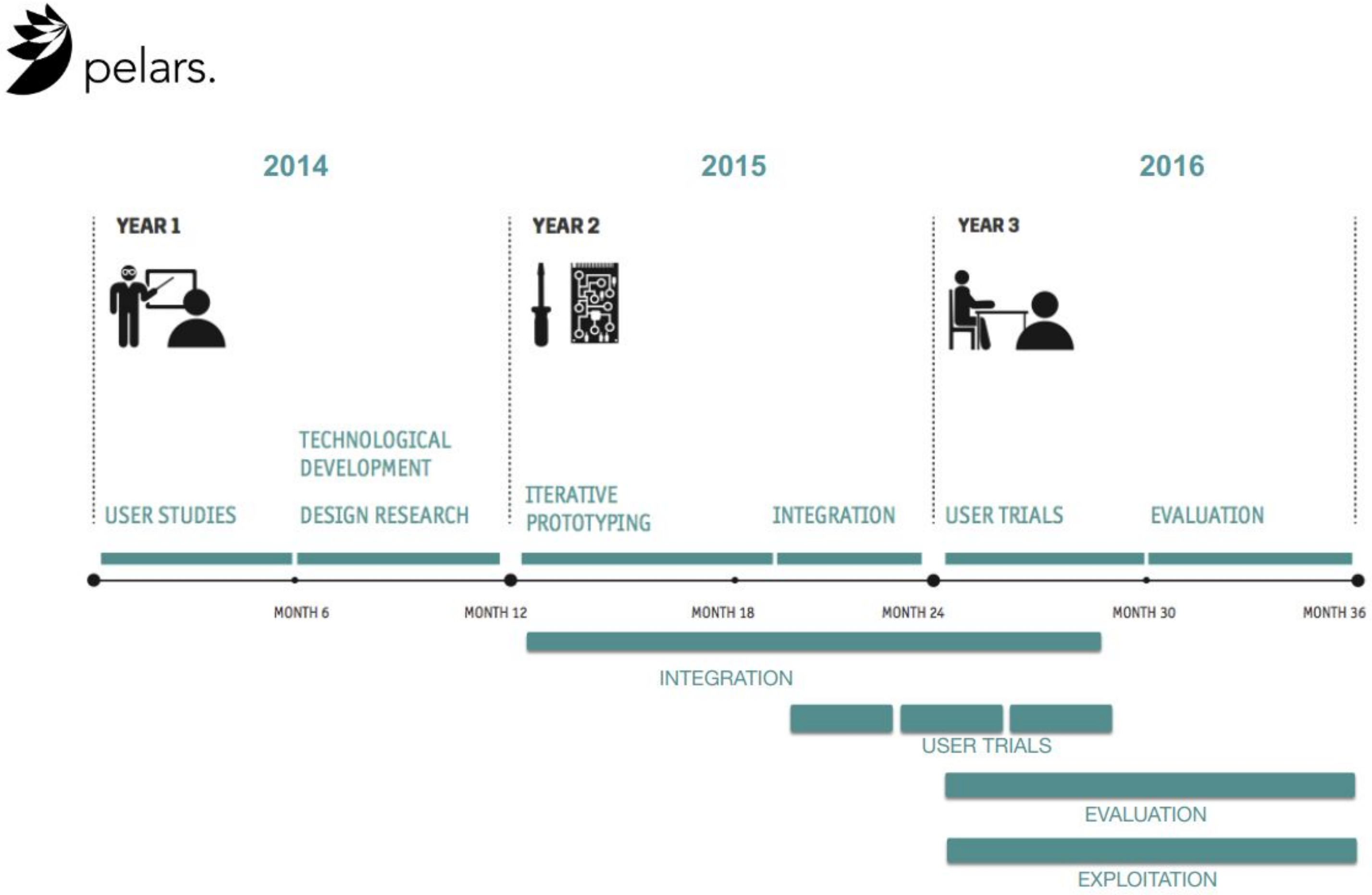
Exhibition

Report

Main characteristics

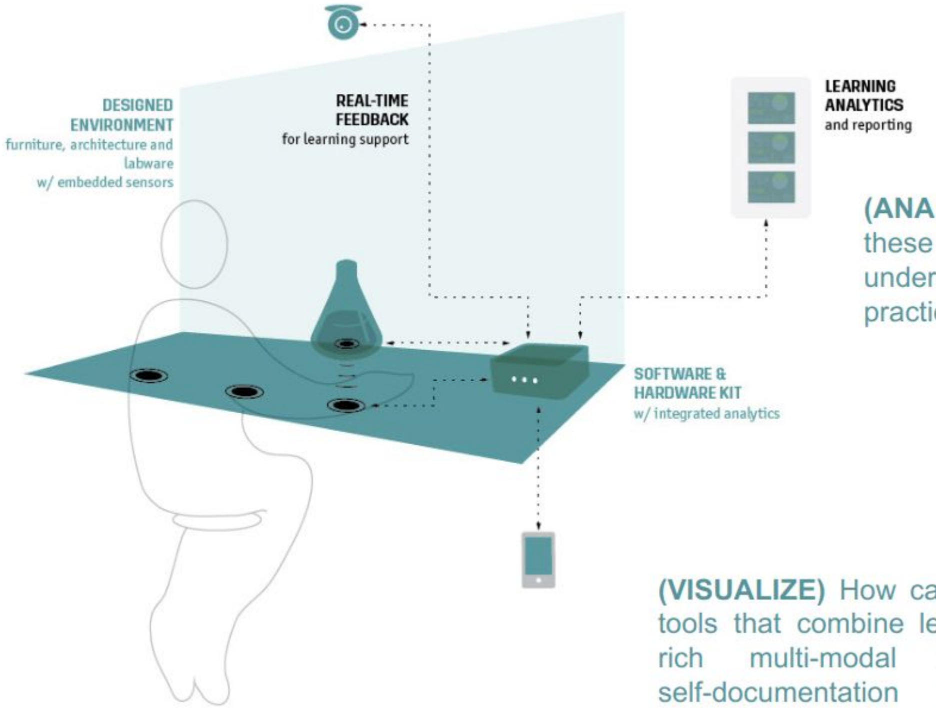
- Co-designed with teachers at regional scale
- Specially designed kit
- Reached out to the whole of Spain after 5 years
- Project Based Learning
- Formal education
- No assessment mechanism provided
- Not every school is ready to replicate this (estimated 60%)
- The final goal has a big effect on the students
- Duration: months, fixed

Case # 3:
PELARS, EU


pelars.
2014
2015
2016
YEAR 1
YEAR 2
YEAR 3
TECHNOLOGICAL DEVELOPMENT
USER STUDIES
DESIGN RESEARCH
ITERATIVE PROTOTYPING
INTEGRATION
USER TRIALS
EVALUATION
MONTH 6
MONTH 12
MONTH 18
MONTH 24
MONTH 30
MONTH 36
INTEGRATION
USER TRIALS
EVALUATION
EXPLOITATION

pelars.

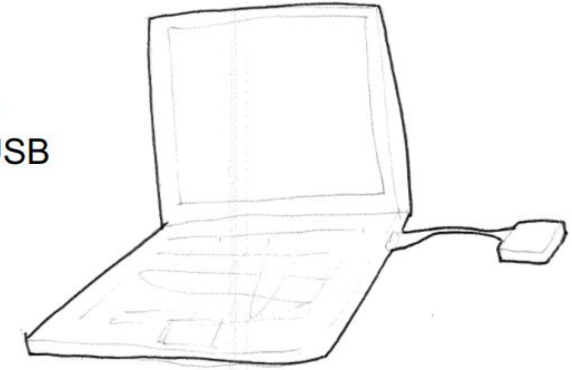
(**CREATE/CAPTURE**) What new data analytics can be derived from the hands-on learning of STEM subjects?



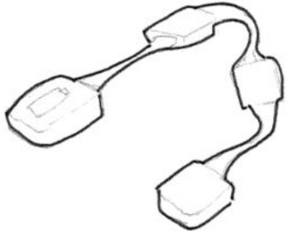
(**ANALYZE/REASON**) How can these data analytics be used to understand and support practice-based learning?

(**VISUALIZE**) How can we develop visualization tools that combine learning analytics data from rich multi-modal sensors and students self-documentation to provide meaningful information?

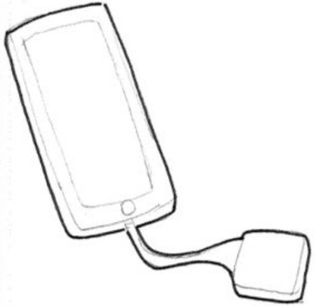
Mode 1: single sensor
connected to PC via USB



Mode 4: multiple sensors
connected to each other via I2C,
including battery module



Mode 1 bis: single sensor
connected to smartphone
via OTG connector



Different use cases of Arduino Eslov

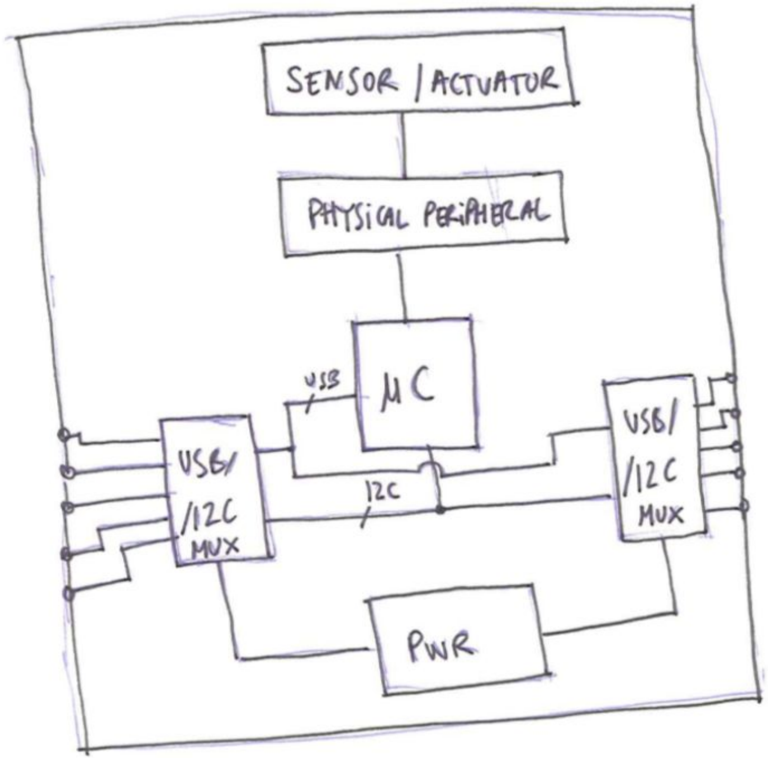
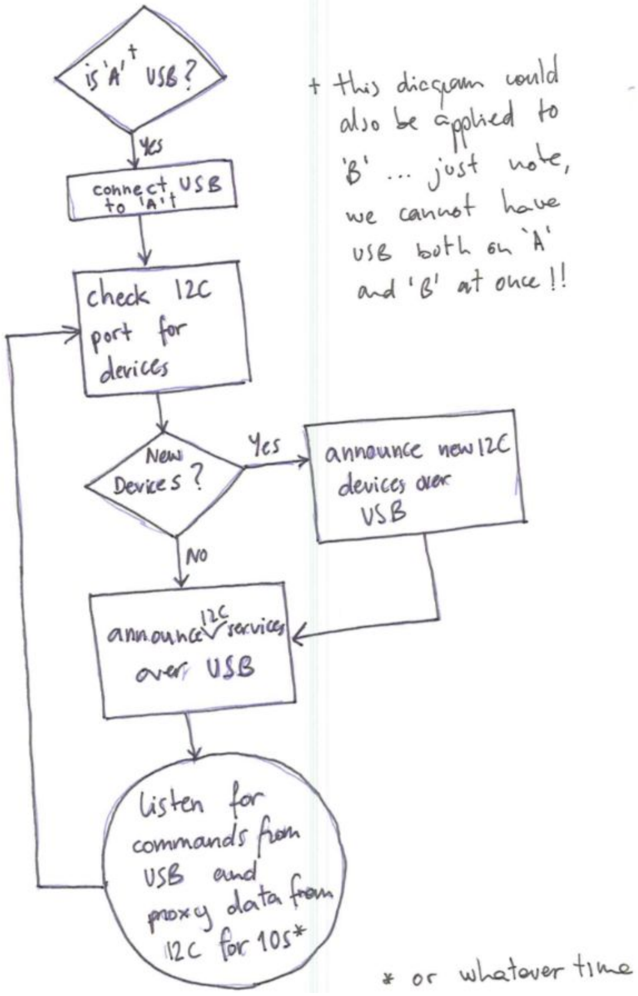
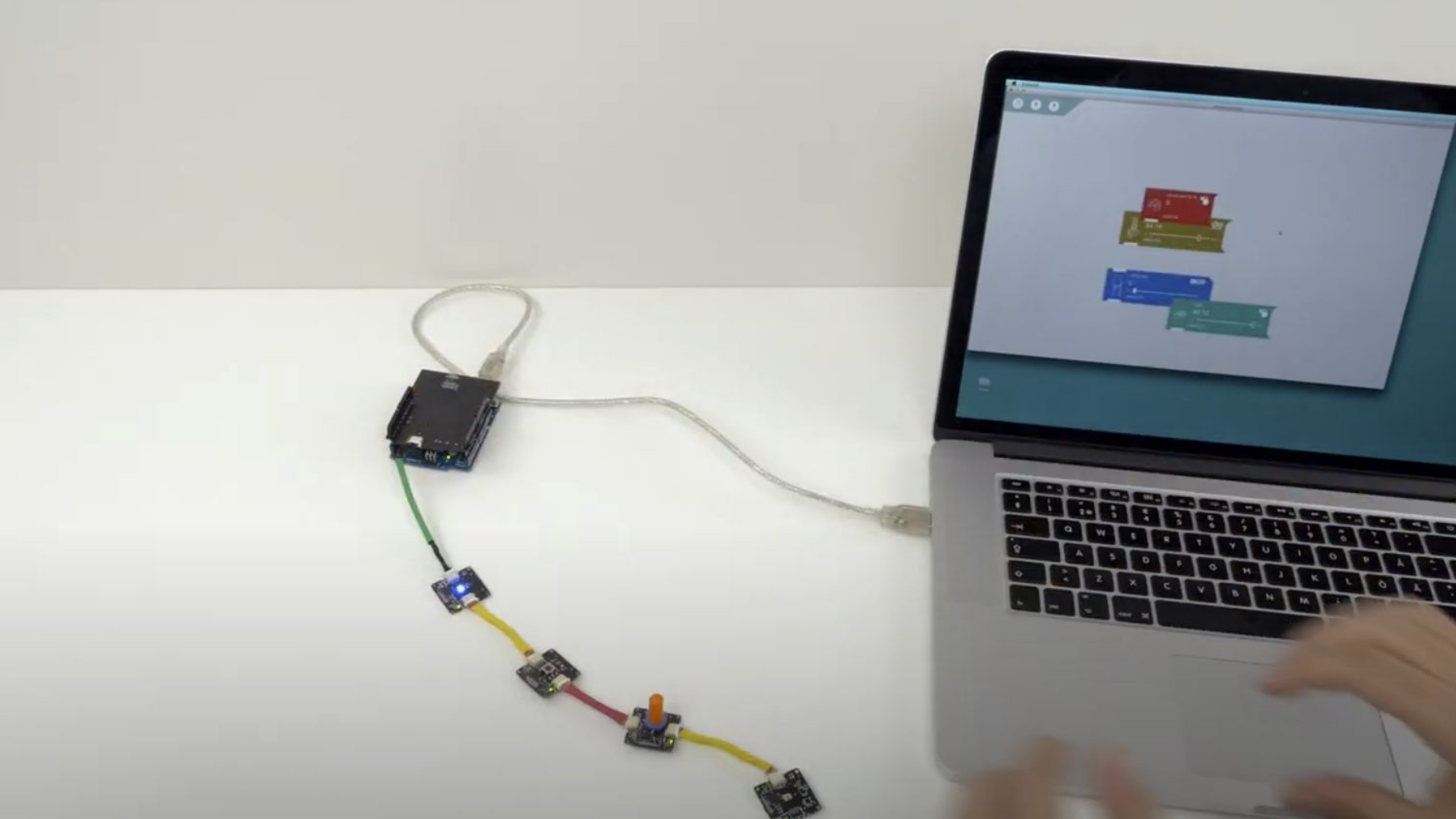
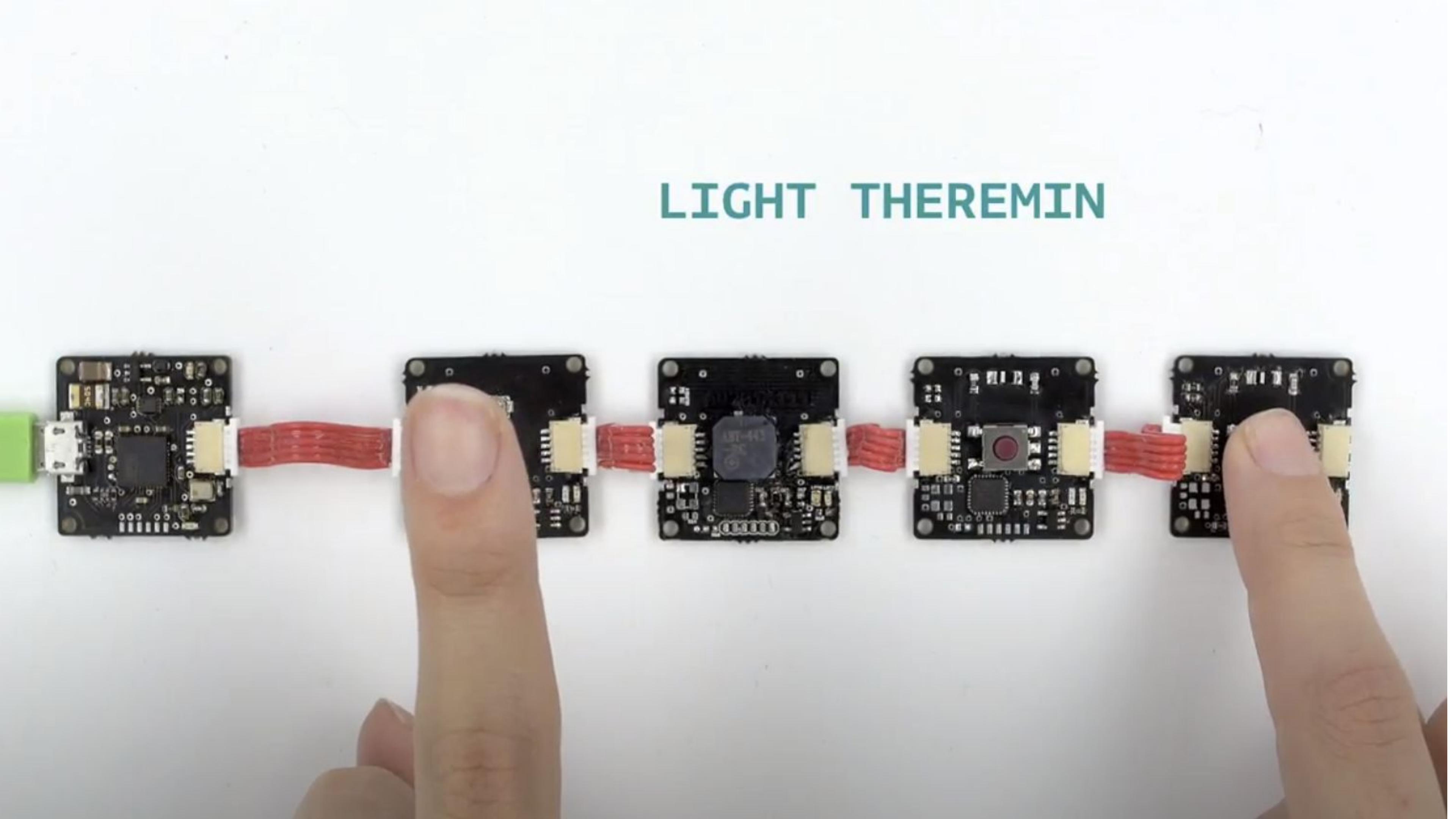


Diagram of a generic Arduino Eslov block






LIGHT THEREMIN

Format

Introduction

Design brief

Project building

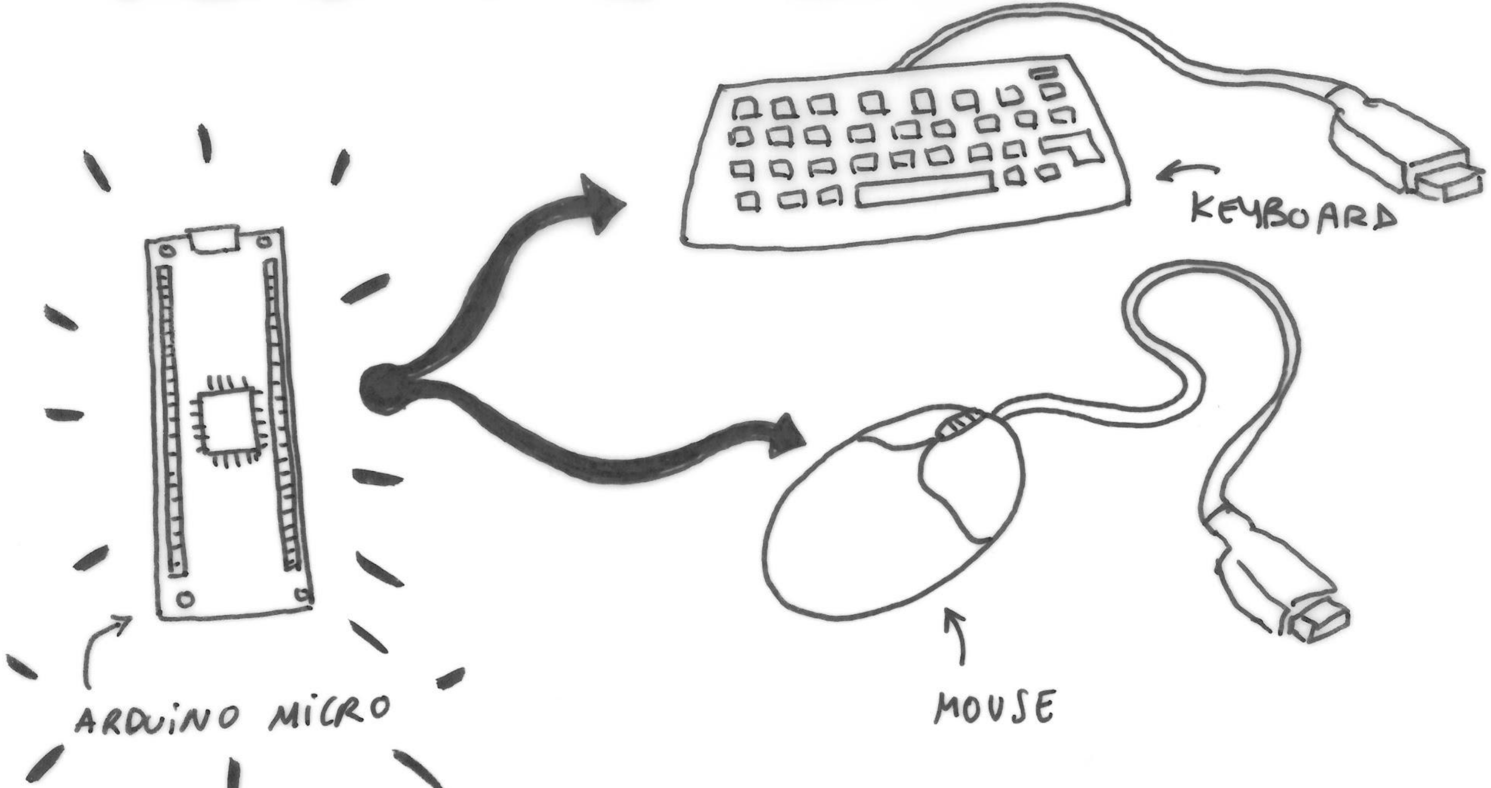
Exhibition

Main characteristics

- Experimental [research] setup
- Blended electronic materials with crafting ones
- Full classes would come to test
- No theoretical component, and no previous instruction
- Project Based Learning
- Duration: 1 hour to final result

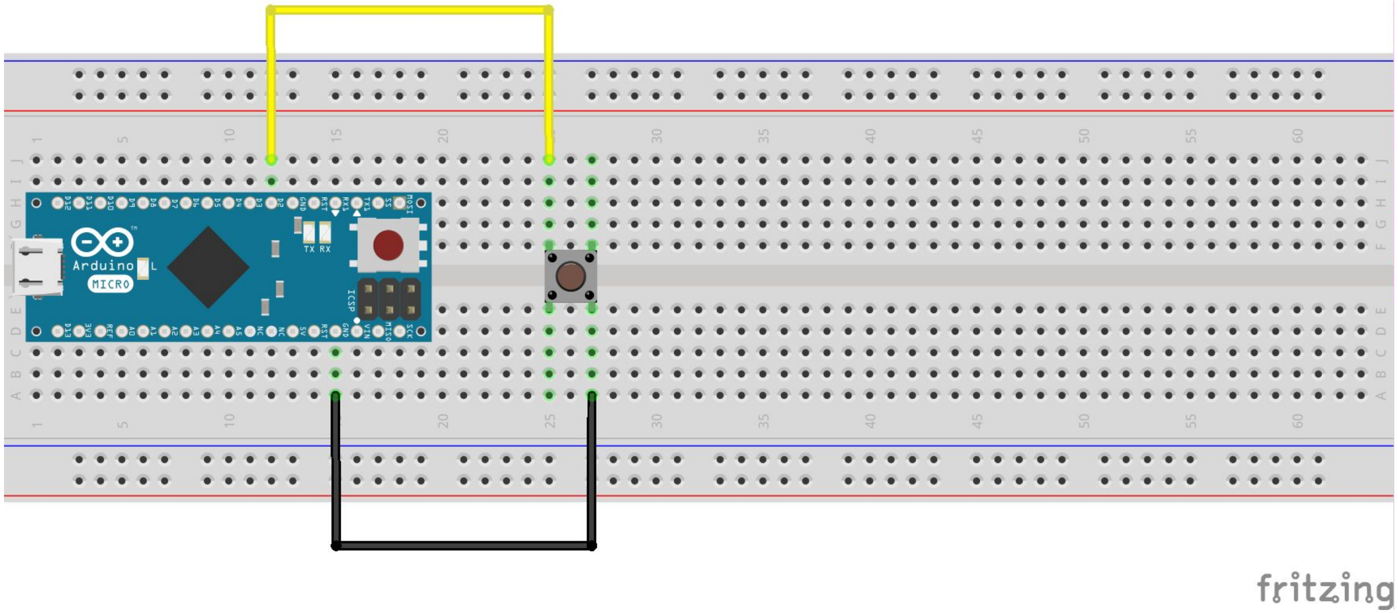
Case # 4:
Cardboard workshop,
Malmö, Sweden

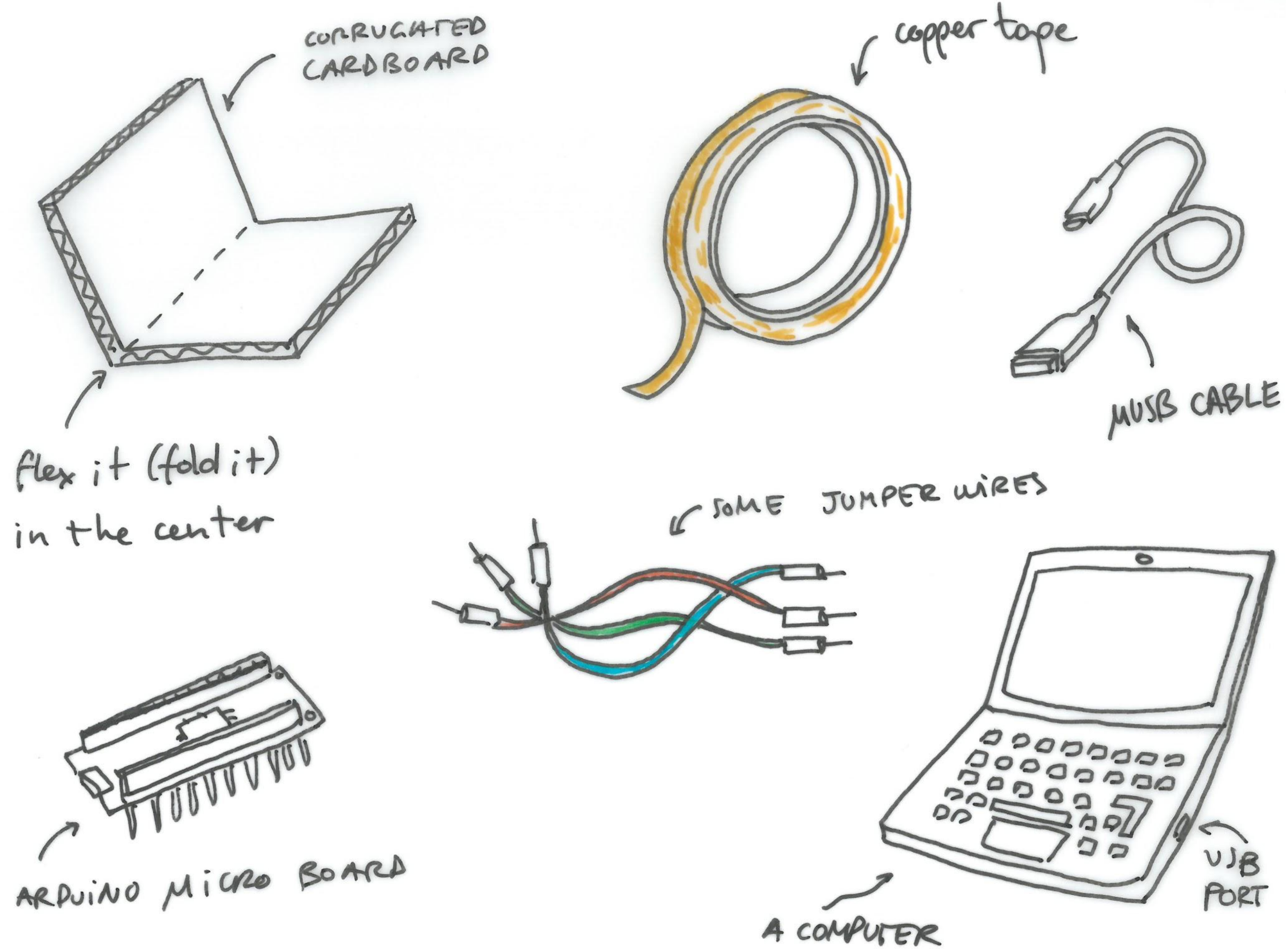
YOUR CAN BE:



YOUR FIRST BUTTON

AT A GALAXY FAR FAR AWAY...


Arduino
MICRO
fritzing


CORRUGATED CARDBOARD
flex it (fold it) in the center
copper tape
μUSB CABLE
SOME JUMPER WIRES
ARDUINO MICRO BOARD
A COMPUTER
USB PORT


SURGE

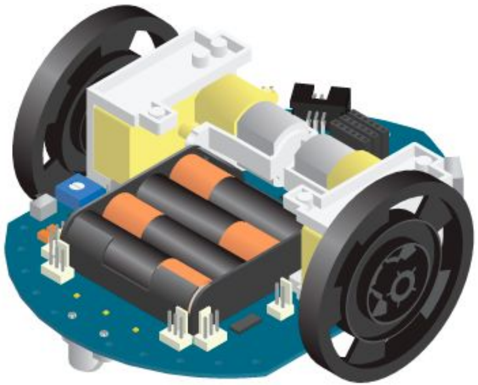
Format

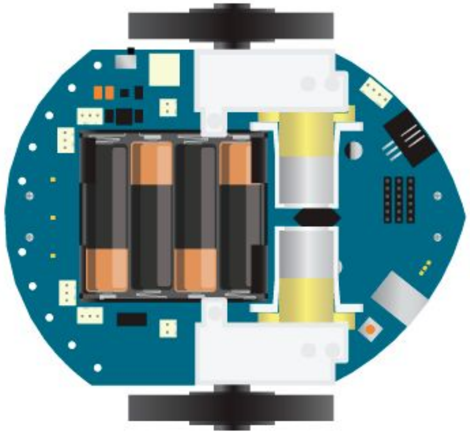
Monday		Tuesday	Wednesday	Thursday	Friday
Introduction to prototyping	Basic intro to Arduino	Program HID device	Basic intro to Scratch	Project building	Exhibition

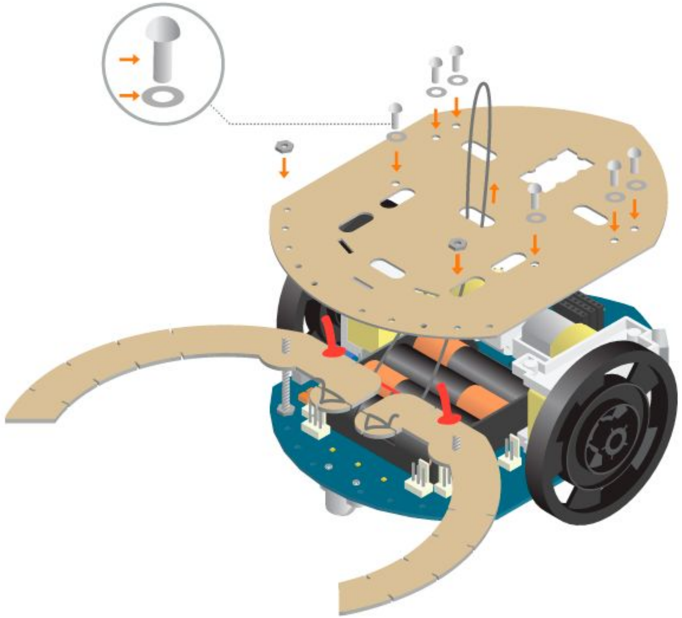
Main characteristics

- Blends low cost materials (considered a design quality)
- Off-the-shelf microcontroller boards
- Ran at the beginning of the education programme (thus no experience required)
- Project Based Learning
- Formal education
- Assessment: functioning project, presentation, participation in the module
- Duration: one week, fixed

Case # 5:
Etopia KIDs, Zaragoza, Spain








KIDS
26/06/2014


Cm52
Cm52

Format

Introduction to robotics

Basic intro to Arduino

Intro to sensors

Intro to motors

Project building

Challenge

Week 1

Week 2

Main characteristics

- Blends low cost materials (considered a design quality)
- Kit specifically designed for the occassion
- Summercamp
- Project Based Learning
- No assessment
- Duration: two weeks, fixed

Note: the kids kept the robots, since there were over 80 robots distributed, this had the side effect of creating a small community of roboticists that would meet monthly

Case # 6: Aguascalientes al Espacio, AGC, Mexico

Format

Problem definition

Call for applications

Team selection

Weekly courses

- Arduino
- Remote lab

~ 8 weeks project building

Launch

Report

Main characteristics

- Informal education (some schools manage to bring it in)
- Off-the-shelf components, all teams share a lab
- Limited group size
- Theoretical component from an external source
- Project Based Learning
- Complex logistics
- Duration: months, variable

What is the impact of the Arduino platform in teaching? Does it help students learn about embedded technology?

We got an opportunity through a third party.

- Electronic Cats is an SME based in Aguas Calientes, MX, dedicated to the design of small electronic products (hardware, firmware)
- Furthermore, EC design and implement experimental education experiences in STEAM for the regional government.

Know our education platform

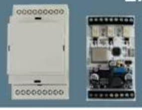
Learn everything about IoT, we have the educational hardware for you to learn to develop your projects

Sign Up

Education

ELECTRONIC CATS

Embedded



For the little ones

Electronic boards manufacture and desing service

All our products are Open Hardware

Consulting and training service

Firmware development

Aguas Calientes al Espacio edition 2022.

- In this activity, EC created a remote farming laboratory, where the different schools could time-share a robotic farm where to grow vegetables. They simulating a future remote-farming scenario in a different planet.
- For students and teachers to participate in this project they had to be introduced to a series of complex concepts in embedded technology, programming, design, building, etc.


BANDACATS
悟


AGUASCÁLIE
AL ESPA
ASTRO
MUNICA

Schools, teachers and students.

- This project reached out to a group of 14 schools in the region of Aguascalientes, MX.
- Each school joined the initiative with one team of 8 to 11 students.
- Students in the team would join by their own will, no selection mechanism was applied for the students (as a rule).
- It is likely that students adopted roles at the time of working with the project.

REPORTE SEMANA #19

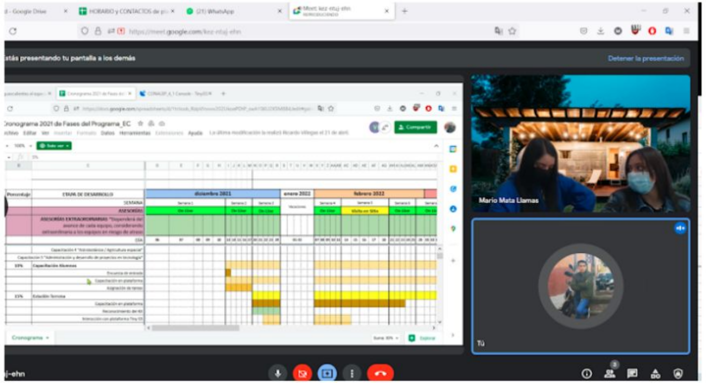
No. 11 de 12

Capacitación de misión espacial del
23 al 26 de Mayo de 2022

DESCRIPCIÓN BREVE

Actividades desarrolladas semanalmente para el proyecto: Aguascalientes al espacio 2022.

Evidencias de visita



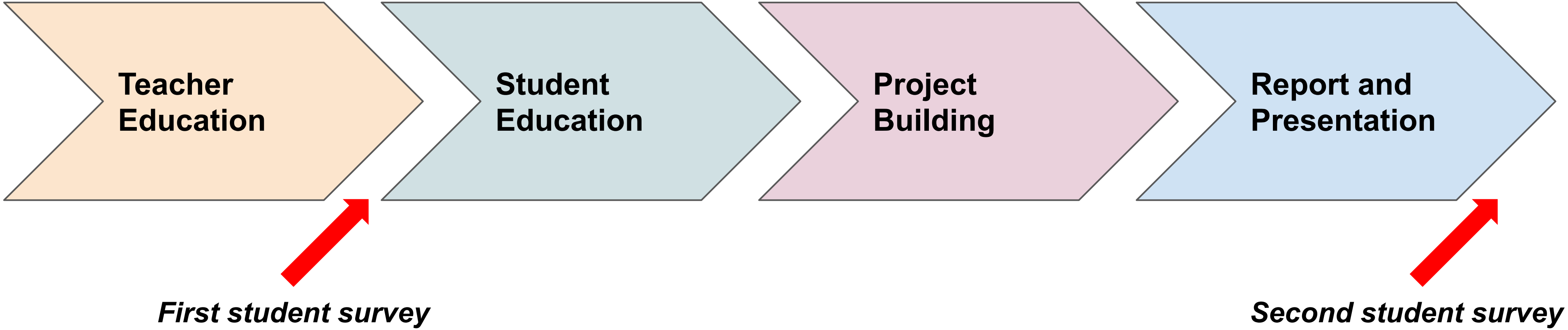
The learning process.

- Participating in the project implied participating in a series of lectures and events to introduce teachers and students to the materials.
- Teams were expected to conduct an experiment (all teams had access to the same tools), document it, and present it.
- The teams' progress was followed using rubrics.

Asignación de porcentaje de Avance.

Porcentaje	ETAPA DE DESARROLLO
5%	**School team forming**
	Parche de misión
	Lectures with experts
	Capacitación 1 "Diseño Gráfico"
	Capacitación 2 "TinyGS"
	Capacitación 3 "Cubo Satellites"
	Capacitación 4 "Astrobotánica / Agricultura espacial"
	Capacitación 5 "Administración y desarrollo de proyectos en tecnología"
10%	**Introduction for students**
	Encuesta de entrada
	Capacitación en plataforma
	Asignación de tareas
15%	**Land station**
	Capacitación en plataforma
	Reconocimiento del Kit
	Interacción con plataforma Tiny GS
	Programación de Kit TTGO
	Construcción de antena
15%	**Laboratory on distance**
	Capacitación en plataforma
	Asignación de tiempos
	Conociendo mi laboratorio (análisis)
	Control de robot teleoperado
15%	**Astro-botanics**
	Sembrando (1ra oportunidad)
	Sembrando (2da oportunidad)
	Sembrando (x oportunidad)
	Aplicación de abono
	Mantenimiento a robot (Suspensión)
	Recolección
5%	**Data from pico-satellites**
	Reporte de misión lectura de datos
5%	**Improvements**
	Mejora a antena
	Mejora a Astrobot
	Reporte de actualizaciones y gastos
5%	**On-capsule recording**
5%	**Exiting survey**
10%	**Final report**
5%	**Presentation**
5%	**Technical demo**

The survey process.




Encuesta de Entrada Profesores

Our experiment.

- Great opportunity for us to measure the learning process by implementing a pre-post measuring point and to compare the knowledge on relevant concepts before and after the activity.
- Our goal is to determine whether this kind of STEAM activity can be considered as a good learning mechanism.
- In particular, whether it affects students' **knowledge and competence in skills** related to STEAM components.

Research questions

1. Does students' **self-reported knowledge of STEAM tools** change after program implementation?
2. Does students' **actual STEAM competence** change after program implementation?
3. Which STEAM skills improve more after program implementation?


AGUASCALIENTES
AL ESPACIO
SATELITAL
CHALLENGE
GOBIERNO DEL ESTADO

Study design: Pre and Post STEAM program survey

- **Participants**: 47 students (16 females, 31 males)
- **Age**: 17 (16-19)
- **Stage**: Secondary school
- **Schools**: 14 different schools of Aguascalientes (Méjico)
- **Digital accessibility**: 100% reported access to Internet at home or via Smartphones and 92% reported access to a PC at home.

The STEAM survey: Structure

- Part 1_Consent form and Demography
- Part 2_Self-reported STEAM knowledge
- Part 3_Test of STEAM knowledge

- Two Phases: Pre and post
- Two versions: Students and Teachers

Self-reported STEAM knowledge

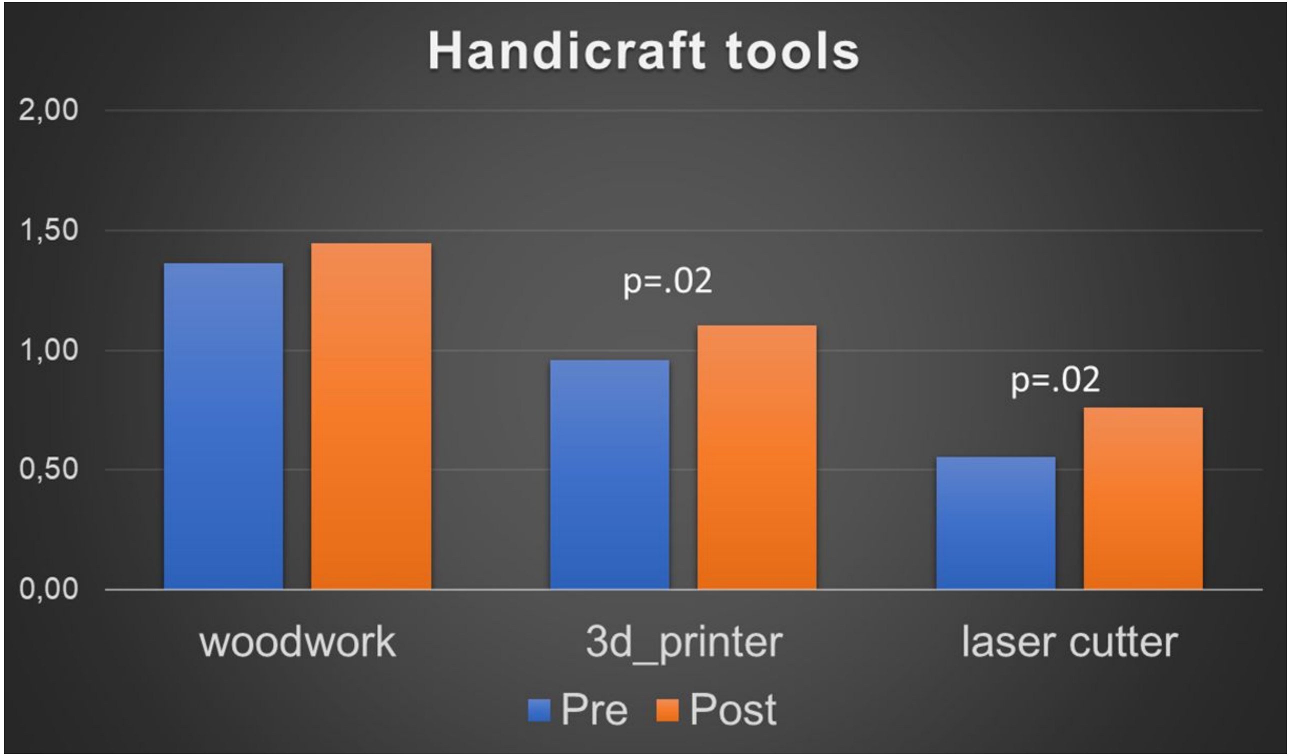
- Students rated their knowledge of 41 tools using a 3 point likert scale:

  0="I don't it, 1= I know it", 2= "I use it"

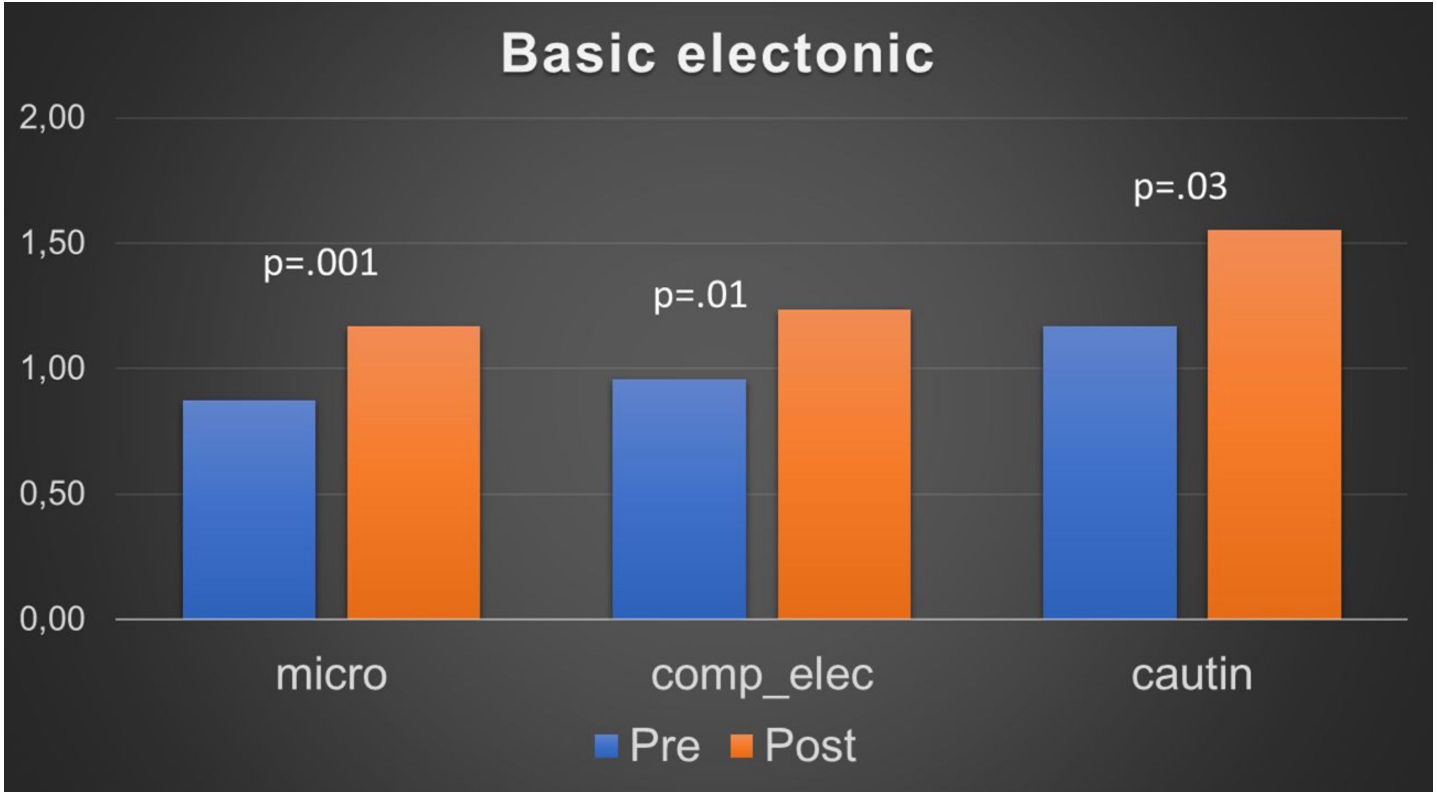
- The 41 ítems were grouped in 9 categories.
- Scale reliability measured with Cronbach's alpha = .93 (p<.001).

Categories	N_Items	STEAM component
1. Handicraft tools	3	Technology, Art
2. Basic electronic	3	STEM
3. Digital literacy	2	Technology
4. Lab tools (9)	9	Technology, Art
5. Software (4)	4	Technology
6. Microcontroler in C (Arduino)	1	STEM
7. Microcontroler in Bloks (Microbit)	1	STEM
8. Graphic Design	7	Technology, Art
9. Presentation tools	11	Technology, Art

Self-reported STEAM knowledge



Self-reported STEAM knowledge



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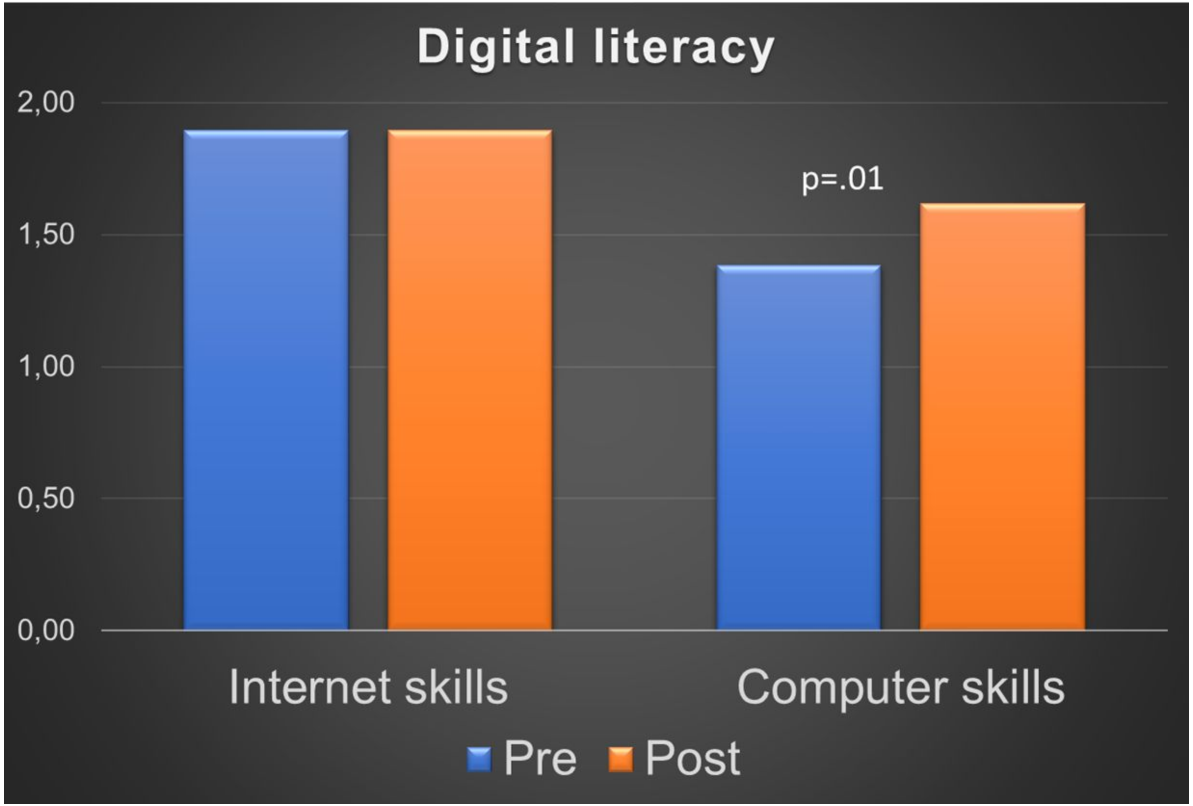
Self-reported STEAM knowledge



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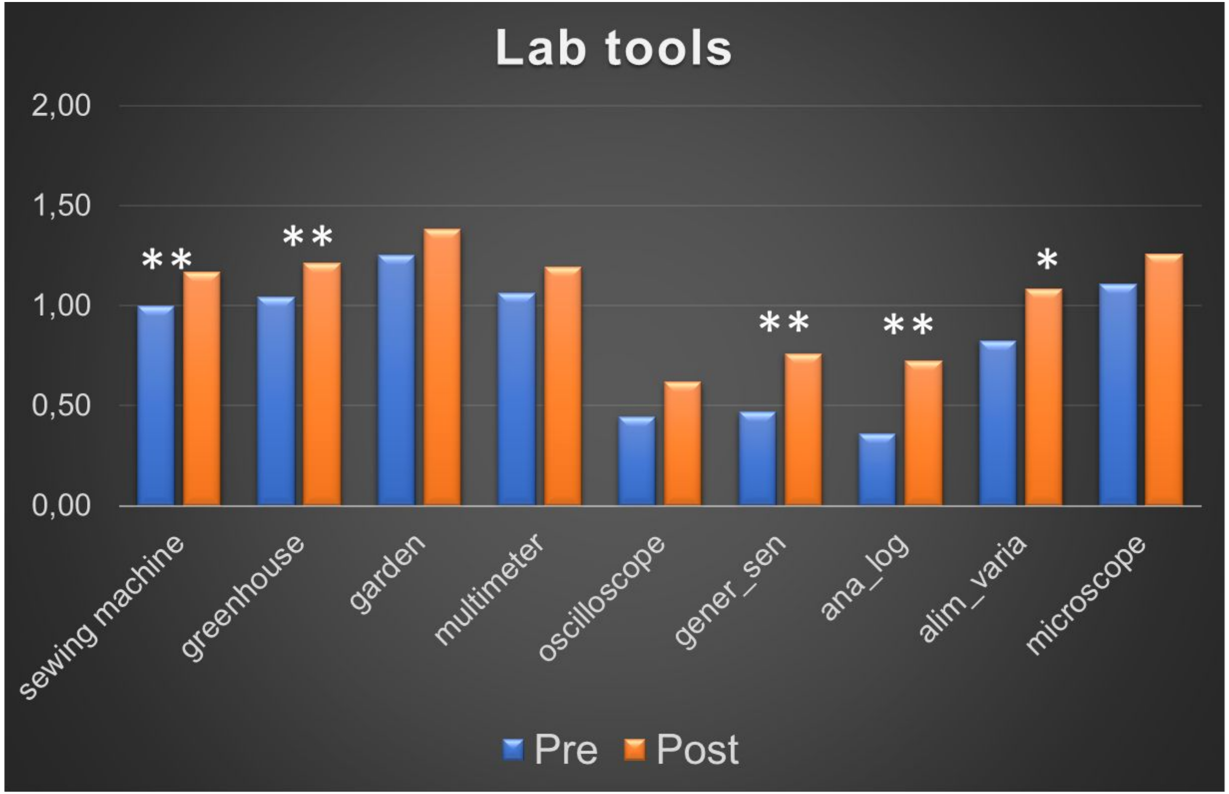
Self-reported STEAM knowledge



**P-value <.01; * P-value <.05

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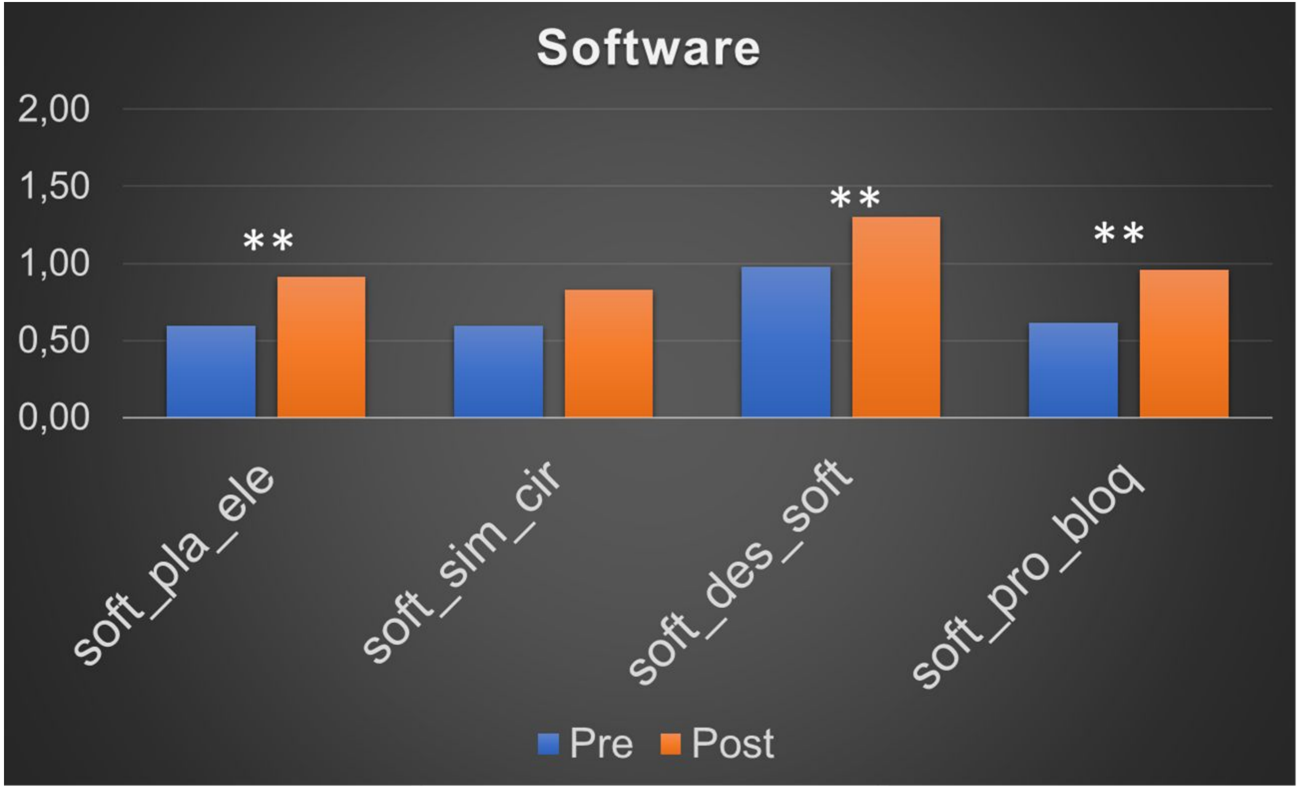
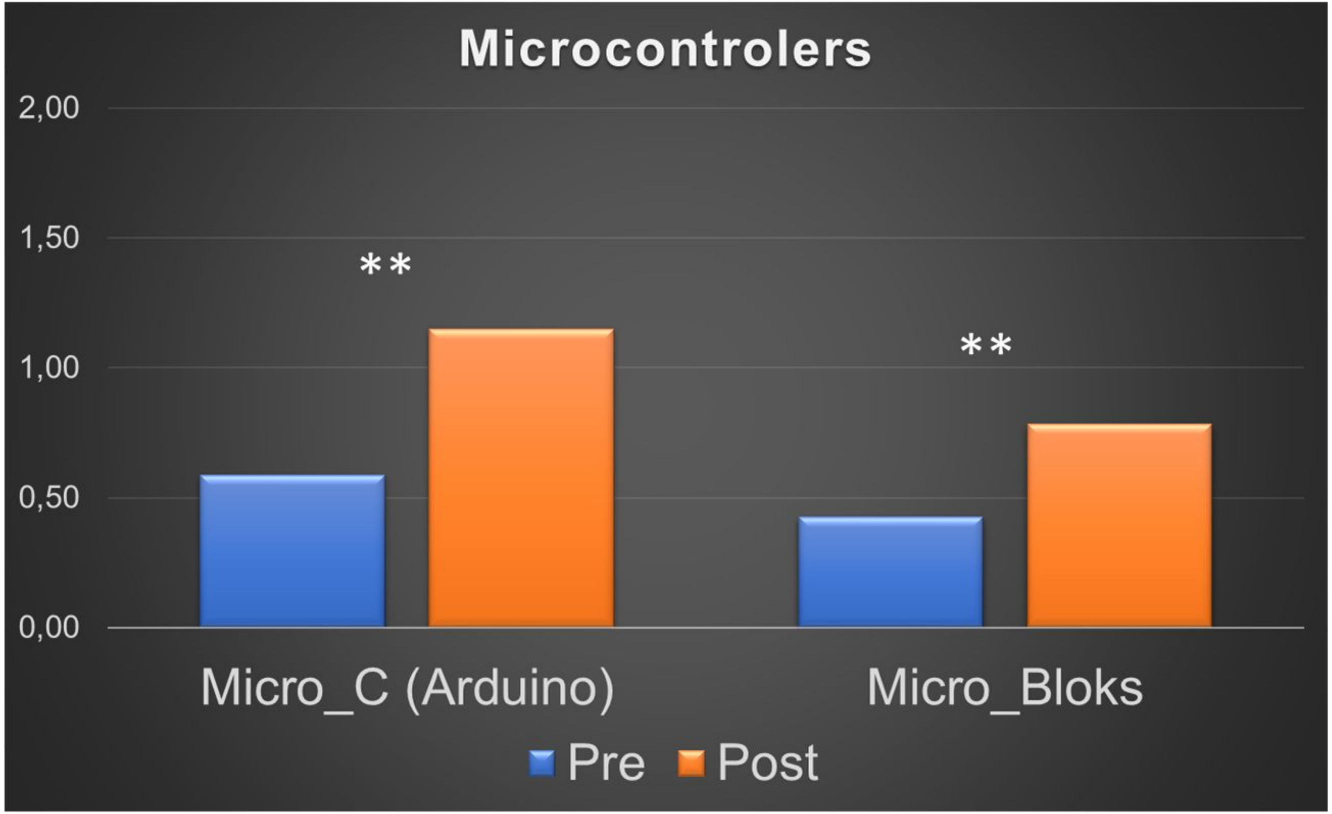
Self-reported STEAM knowledge



**P-value <.01; ** P-value <.05

Self-reported STEAM knowledge



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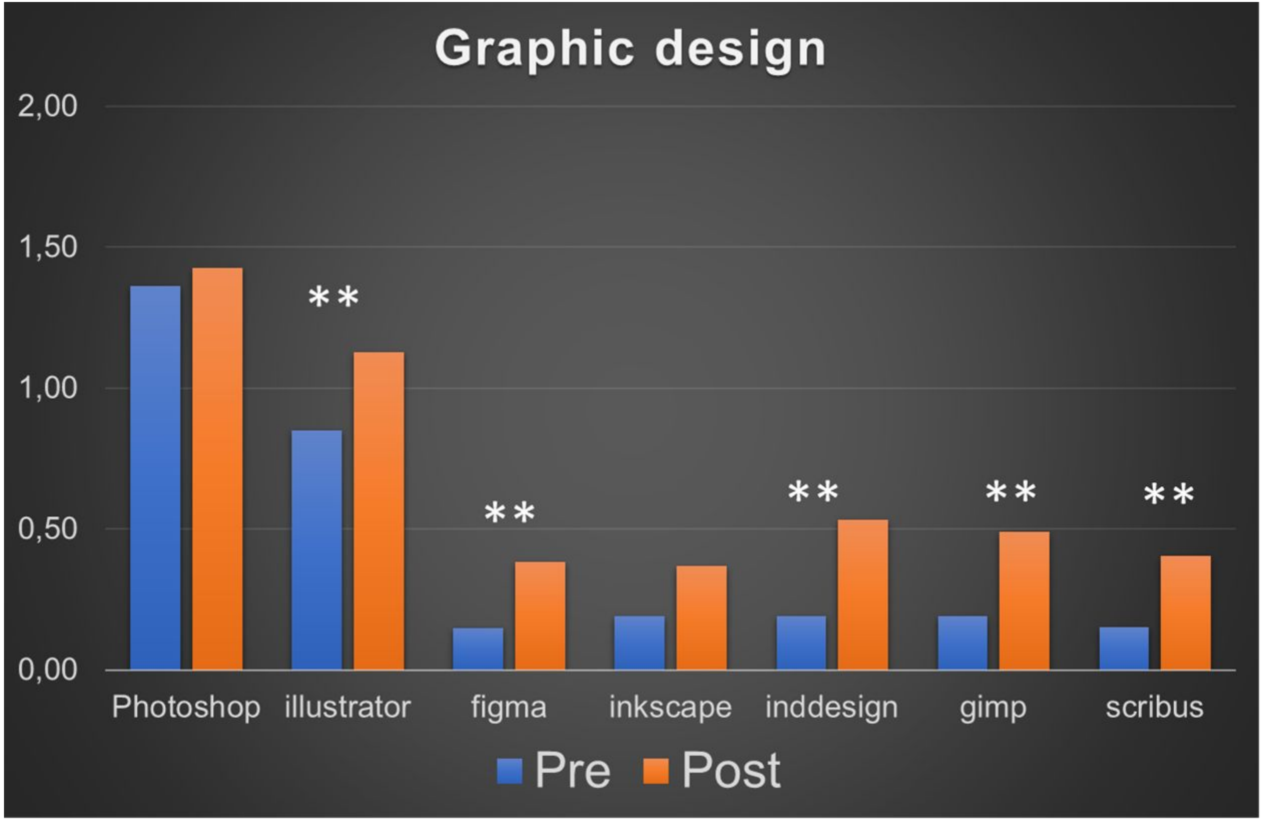
Self-reported STEAM knowledge



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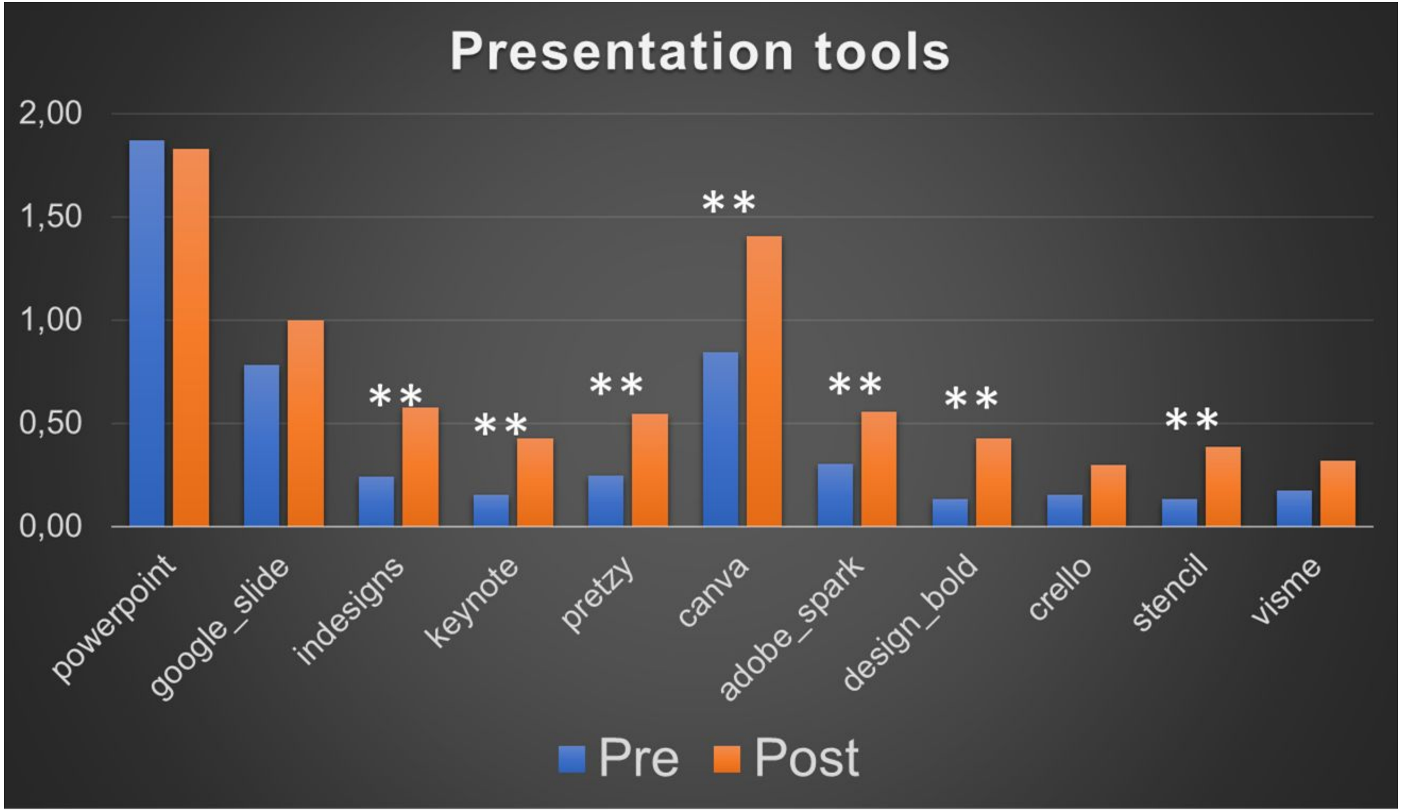
Self-reported STEAM knowledge



**P-value <.01; ** P-value <.05

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Test of STEAM competence

- Participants answered 19 multiple choice questions grouped in 3 categories:
- Measure: Percentage of correct answers per category

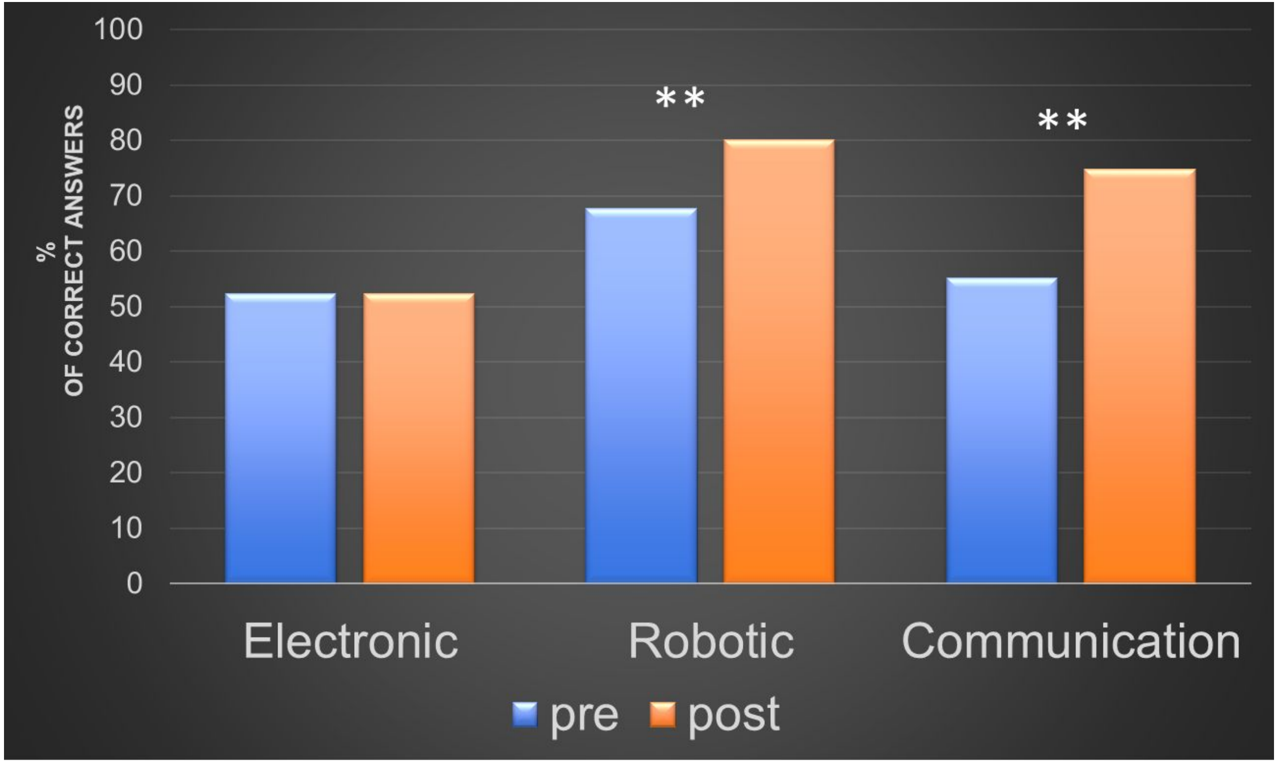
Categories	N_Items
1. Electronic	7
2. Robotic	7
3. Communication	5

Test of STEAM competence

- Participants answered 19 multiple choice questions grouped in 3 categories

Example of “Electronic” question:
Which electronic component converts electrical energy into heat?
1 = The electrical part
2 = The resistor (correct)
3 = The LED diode

Test of STEAM competence



**P-value <.01; ** P-value <.05

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Conclusions & further work

- Does students' **self-reported knowledge of STEAM tools** change after program implementation?
  - Yes, students self-reported higher knowledge after
- Does students' **actual STEAM competence** change after program implementation?
  - Yes, students showed higher STEAM competence after
- Which STEAM skills improve more after program implementation?
  - Robotic and Communication
  - Is Electronics more difficult?, should be the program be improved to strengthen electronic?
  - How can "art" competence be measured?

Let’s wrap this up
in style.

Findings on Spaces

Spanish Maker Timeline

1990

LAN Parties - Campus Party

2000

First hackerspaces created
First hackmeeting in Barcelona
Medialab Madrid launches

2001

Institute of Advanced Architecture of Catalonia (IaaC) launches

2005

Reprap project launches
Arduino project launches
Fab: The Coming Revolution on Your Desktop is published
First Fablab Users Meeting (MIT)

2006

Interhacklab meeting in Madrid
Hangar launches its medialab in Barcelona
First Maker Faire in Bay Area
Second Fablab Users Meeting (Norway)

2007

IaaC launches Fablab Barcelona

2008

Summer Lab, a meeting on experimental digital arts is launched by Laboral (Gijón)

2009

Interactivos 09, at Medialab-Prado, brings together several RepRap pioneers
Kernel Panic hacklab closes

2010

Rooted conference on cybersecurity launches
Barcamps emerge as meeting points for Arduino enthusiasts

2011

New institutional fablabs in Sevilla, Leon, Valencia, Asturias
Absolut lab launches and colapses in Madrid
Open Source Hardware Conference launches
Calafou, a self defined post-capitalist ecoindustrial colony, was born

2012

DARPA funds Maker Media to expand maker outreach

2013

First independent makerspaces launch in Madrid; Tenerife and Barcelona.
First mini maker faires appear in Bilbao and Barcelona

2014

New programs emerge to bring Technology, Programming and Robotics into the regular curriculum
Fab10, international fablab conference, is celebrated in Barcelona
HP launches 3D Printing factory in Sant Cugat (Barcelona)

2015

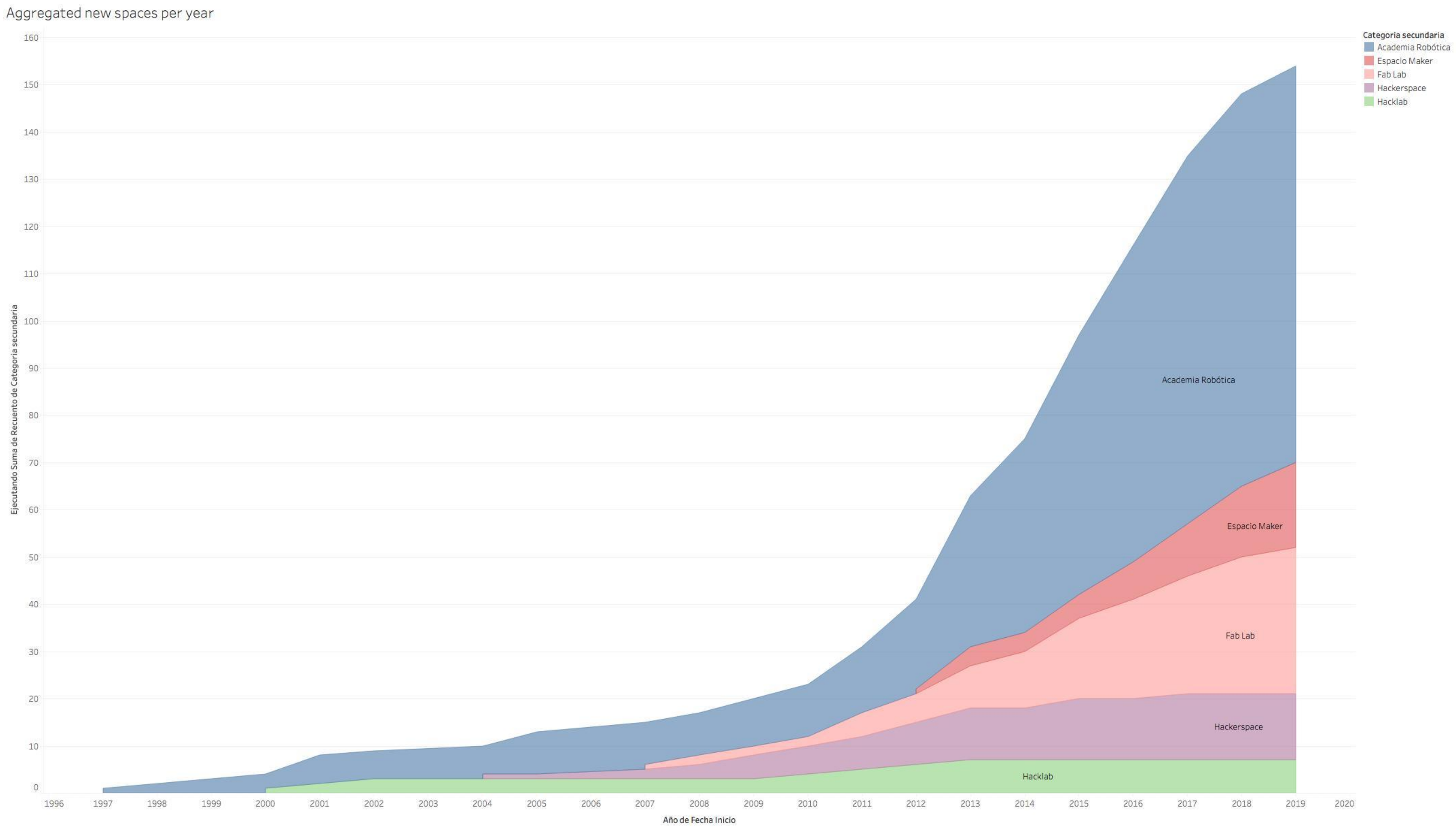
First regional fablab / makerspace events in Gijon and Ourense
New independent fablabs and institutional makerspace appear
NMC Horizon report includes makerspaces as a tool for shcools in a 1-2 year timeframe

2017

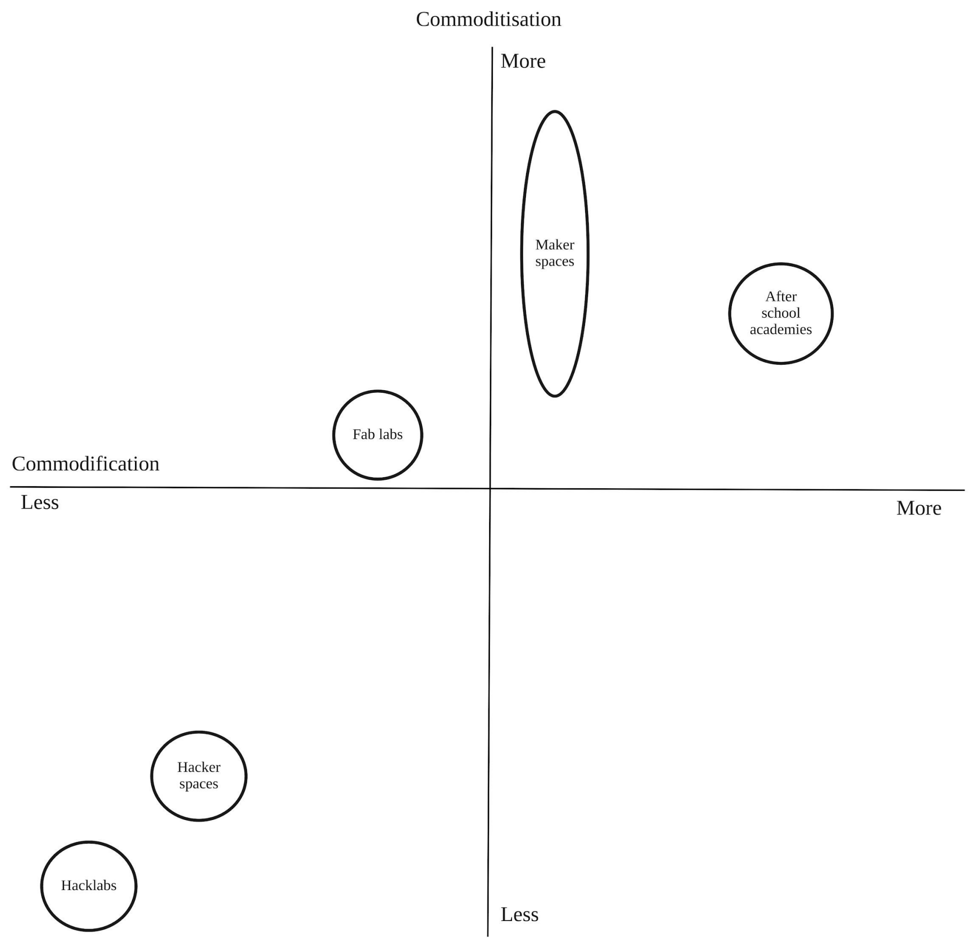
US Embassy and Ministry of Education host a conference at Medialab'Prado about Makerspaces in Libraries
Tradeshows open maker areas or corners to promote STEM education

2018

City councils promote makerspaces and maker programs in libraries, education, etc.



The plot of Running Sum of Count of Categoria secundaria for Fecha Inicio Year. Color shows details about Categoria secundaria. The marks are labeled by Categoria secundaria. The data is filtered on Fecha Inicio Year and Categoría Principal. The Fecha Inicio Year filter keeps 24 members. The Categoría Principal filter keeps Apertura. The view is filtered on Categoria secundaria, which excludes 11 members.


Commoditisation
More
Maker spaces
After school academies
Fab labs
Commodification
Less
More
Hacker spaces
Hacklabs
Less

Findings on Spaces

List of open questions to consider

- How do you deal with classes operating at multiple speeds?
- In the EU we follow an educational standard based on the Bloom's taxonomy (LOs), assessments, and class activities … how about the rest of the world?
- Which are your expectations and how do those align with the ones from the students?
- Affordances ⇔ limitations, which are the ones you have detected?
- Repetition: is it acceptable to you? What about the innovation aspects?
- Online vs. Offline

List of open questions to consider

- Languages (not pogramming, but the other ones)
- Labs vs. personal kits: when and where?
- Kits vs. toolboxes: what is best?
- AI specific: dependency layers (C-NN-platforms)
- Guided vs. exploratory courses
- What is left when novelty has wear off?

There will always be people looking into creative uses of technology.


11:33
AR
Poliwag
CP ???
70

Thanks 👩‍🎓🧑‍🎓
for coming by!

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