Energy transition, Climate change, Renewable fuels, Circular economy
Experience of EU projects on the secondary education.

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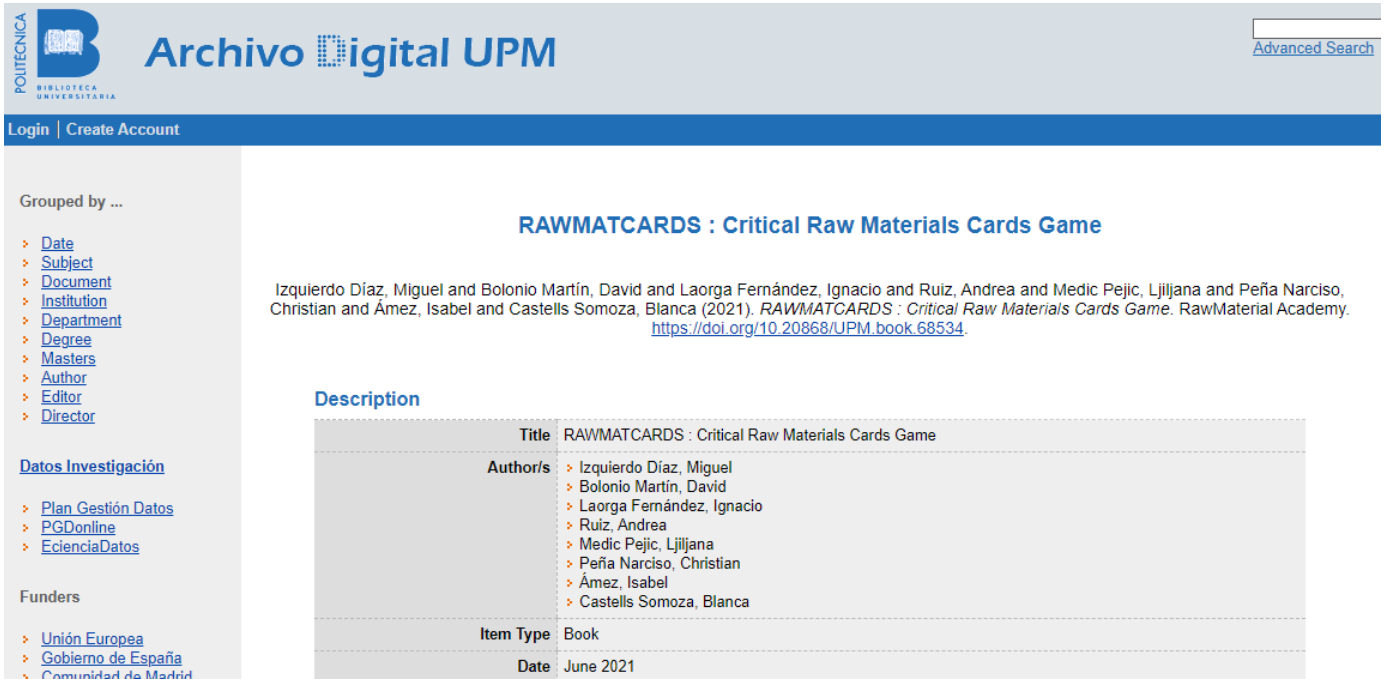
POLITÉCNICA

TECMINERGY
Centro Tecnológico de Seguridad y Calidad en Industrias Energéticas y Minas

UPM INTERNSHIP SCHEME

	Week 1					Week 2		Week 3	
17:00-18:00	17:00-18:00	17:00-18:00	17:00-18:00	17:00-18:00	17:00-18:00	15:00-19:00	15:00-19:00	15:00-19:00	15:00-19:00
All	Tutor 1	Tutor 2	Tutor 3	Tutor 4	Tutor 5	All tutors	All tutors	All tutors	All tutors
Internship program presentation	Lilliana Medic	Christian Peña	Miguel Izquierdo	Isabel Amez Blanca Castells	David Bolonio	Groups/starts up Creation	Teamwork	Group mentoring	Works presentations
RM@Schools	Circular Economy	Electric batteries	Environmental impact	Industrial safety Company	Design thinking				

RawMatCards



https://oa.upm.es/68534/

CRMs CardGame

Antimony ($_{51}$Sb)

MINERAL(S)

Antimonite ($NaSb(OH)_4$),
Valentinite (Sb_2O_3),
Jamesonite ($Pb_4FeSb_6S_{14}$)

PRODUCTION: 161,948 tonnes/year (2012-2016)

SUPPLY RISK (SR): 2 (2020)

ECONOMIC IMPORTANCE (EI): 4.8 (2020)

RECYCLING RATIO: 38 %

SUBSTITUTION:
- Manufacture of glass (compounds of chromium, tin, titanium).
- Flame-retardant materials (alumina trihydrate, magnesium hydroxide).

COUNTRY OF ORIGIN: China (74 %), Tadzhikistan (8%), Russia (4%)

Antimonite

Source: Colecciones del Museo Histórico Minero D. Felipe de Borbón y Grecia. ETSIME-UPM.

PROPERTIES

- Combined with halogenated flame-retardant compounds constitutes a highly-effective flame retardant.
- (With Pb) Improves tensile strength, corrosion resistance and charging characteristics in Lead-acid batteries.
- Gives resistance to different metal-alloys.
- Antimony trioxide (catalyst).
- In the form of sodium hexahydroxyantimonate becomes a degassing agent.

USES

- Flame-retardant materials (plastics, wire coatings, upholstered furniture, car seats).
- Grid plates, straps and terminals in Lead-acid batteries.
- Manufacturing of Low-load bearings.
- Manufacture of plastic bottles (PET).
- High-quality clear glass.

Catalyst in PET manufacturing

Flame-retardant plastics

PbSb Batteries

Vanadium ($_{23}$V)

MINERAL(S)

Patronite VS_4
Vanadinite $Pb_5(VO_4)_3Cl$
Carnotite
$K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$

PRODUCTION: 61,371 tonnes/year (2012-2016)

SUPPLY RISK (SR): 1.7 (2020)

ECONOMIC IMPORTANCE (EI): 4.4 (2020)

RECYCLING RATIO: 3%

SUBSTITUTION:
- Steel alloy (Mg, Mo, Nb, Ti and W) (tubes and pipes, turbines, automotive parts).
- Ferrovanadium (FeNb).
- Catalyst (platinum, nickel).
- Paints, varnishes (titanium).

COUNTRY OF ORIGIN: *Refined*: China (55 %), South Africa (22 %), Russia (19 %)

Vanadinite

Source: Colecciones del Museo Histórico Minero D. Felipe de Borbón y Grecia. ETSIME-UPM.

PROPERTIES

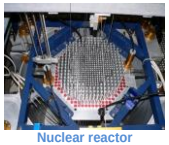
- Considerable increase of strength with small amounts of vanadium.
- Low-neutron-adsorption abilities and it does not deform in creeping under high T.
- V_2O_5 catalyst.

USES

- Ferrovanadium / HSLA additive (mixed with Al or Ti alloys) is used in jet engines, high speed air-frames, axles, crankshafts, gears.
- Nuclear reactors.
- Catalyst (manufacturing of sulphuric acid and maleic anhydride and in making ceramics); added to glass produces green or blue tint.

Jet engines

V_2O_5 catalyst



Nuclear reactor

BARIUM ($_{56}$Ba)

Baryte ($BaSO_4$)

Source: Colecciones del Museo Histórico Minero D. Felipe de Borbón y Grecia. ETSIME-UPM.

Property:
High specific gravity

Weighting agent in drilling fluids (Oil production)

BISMUTH ($_{83}$Bi)

Bismuthinite (Bi_2S_3)
[By-product of Pb and W extraction]

Source: Colecciones del Museo Histórico Minero D. Felipe de Borbón y Grecia. ETSIME-UPM.

Property:
Sn-Bi Low melting point

Fusible alloys in solders (replacement of harmful metals, such as lead)

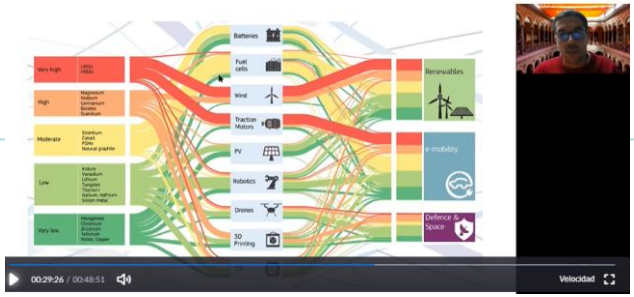
ANTIMONY ($_{51}$Sb)

Antimonite ($NaSb(OH)_4$)

Source: Colecciones del Museo Histórico Minero D. Felipe de Borbón y Grecia. ETSIME-UPM.

Property:
Slow development of ignition

Flame-retardant plastics



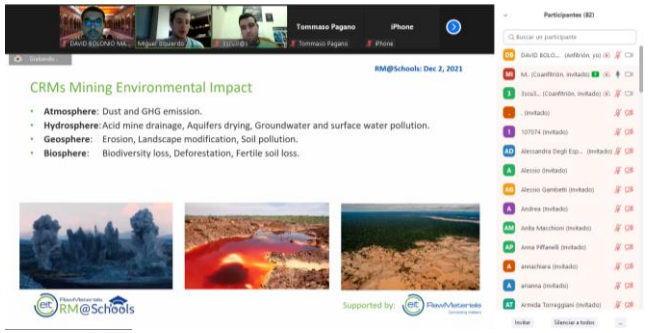
Circular economy and electric car batteries

Design thinking and entrepreneurship

Online

↓

Face to face



WithScience…Conscience

Short videos (max. 1 min)

Importance of mining and raw materials

Young audience

Easy to understand

Social Networks (Instagram)

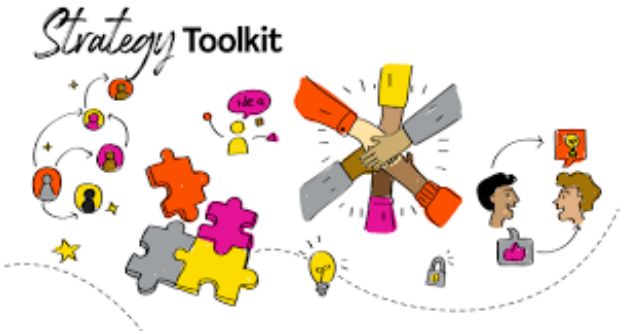
Competition
TikTok short Videos

How many views or likes can you reach?

CONCURSO
RM@SCHOOLS
MINING AND CRITICAL RAW MATERIALS SHORT VIDEOS

BASES DEL CONCURSO

TOOLKITS



Solar Cells, Flotation, Copper recycling…

Reclycing Blue and Recycling Game

Electrochemistry and RawMatCards

Project presentation

What is the project offers to high school students:

- a direct, immersive, contact with the raw materials sector, giving them a first idea of the real world that would facilitate their understanding of sector through seminars, practical experiences and strategies for understand the importance of energy transition circular economy and climate change.

17:00-18:00

Tutor

Blanca Castells

Critical Raw Materials

CRITICAL RAW MATERIALS: ORIGIN


Beryllium

Bertrandite ($Be_4Si_2O_7(OH)_2$)


Dysprosium


Monazite sand (By-product) ($(Ce, La, Nd, Th)PO_4$)

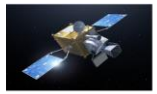

Phosphorus


Apatite

Hinsdalite


Pyromorphite

CRITICAL RAW MATERIALS: APPLICATIONS


Beryllium


Dysprosium

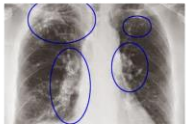

Phosphorus

CRITICAL RAW MATERIALS: MINING ENVIRONMENTAL IMPACT

- Atmosphere: Dust and GHG emission.
- Hydrosphere: Acid mine drainage, Aquifers drying, Groundwater and surface water pollution.
- Geosphere: Erosion, Landscape modification, Soil pollution.
- Biosphere: Biodiversity loss, Deforestation, Fertile soil loss.

CRITICAL RAW MATERIALS: MINING SOCIAL IMPACT

- Asbestosis, silicosis and black lung diseases because of work exposure.
- Child explotation.
- Fostering war and child soldiers.
- Land use competition.
- Unsafe working conditions: miners risk.



Circular Economy

17:00-18:00

Tutor

David Bolonio

Challenges

Europe imports much more natural resources that it exports

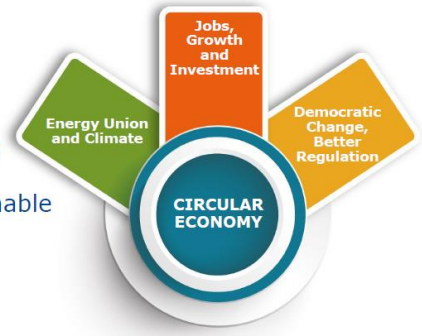
Europe is vulnerable to volatile raw material prices

Europe still generate about five tonnes of waste per person per year on average, and little more than a third of that is effectively recycled

Europe has to secure competitive, affordable and sustainable sources of energy

Circular Economy: a priority

Protecting the environment and boosting competitiveness go hand-in-hand: both are about building a sustainable future.



17:00-18:00

Tutor

Isabel Amez

KEY PRODUCT VALUE CHAINS

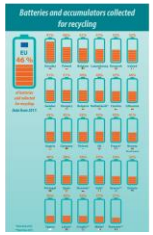
KEY PRODUCT VALUE CHAINS

1. Electronics and ICT

Electrical and electronics are one of the fastest growing waste streams in the EU, **growing annually about 2%.**
Less than **40%** of electronics waste is **recycled** in the EU.
Some of them cannot be reparable.

2. Batteries and vehicles

Its **use is increasing** due to its use in **vehicles**. However seems essential to boost the circular potential of all batteries. European Commission propose a new regulatory framework for batteries.

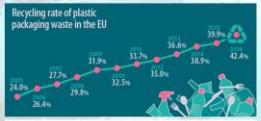


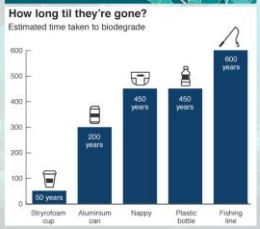
3. Packaging

Europe reached a record. In 2017 were produced **173 kg per inhabitant of packaging wastes**, the **highest level ever**. New Directives reinforce the mandatory essential requirements for packaging to be allowed on the EU market.

4. Plastics

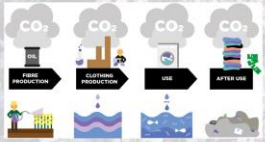
Plastics in the Circular Economy is a challenge of serious public concern. Moreover, **the consumption of plastics** is expected to **double in the coming 20 years**. The Commission will propose mandatory requirements for recycled content and waste reduction measures to improve the situation.





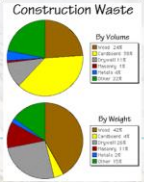
5. Textiles

Textiles are **4th highest-pressure** category for the use of primary **raw materials and water**, after food, housing and transport. They are also the **5th for GHG emissions**.
Nowadays only about 1% of textiles are recycled.



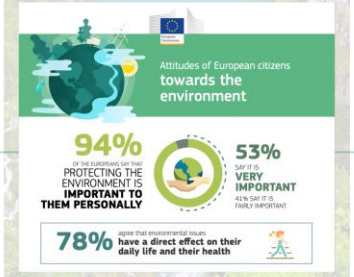
6. Construction and building

The built environment requires vast amounts of resources and **accounts for about 50% of all extracted material**.
The construction sector is responsible for **over 35% of EU´s total waste generation**. Grater material efficiency could **save 80%** of the GHG emissions caused by this sector (between 5-12% of total GHG emissions).



7. Food, water and nutrients

Circular Economy can **restoring biodiversity and natural capital in Europe**. Biological resources are a key input of the EU and play and even more important role in the future.



17:00-18:00

Tutor

Miguel Izquierdo

Critical Raw Materials Impact and contamination

CRITICAL RAW MATERIALS: SMARTPHONE ECOLOGICAL FOOTPRINT

1 g gold recipe

- 1,1 kg explosives
- 4 ton rock
- 380 L water
- 850 g sodium cyanide
- 2 L gasoil
- 3,6 kWh electricity

Material	Contenido en gramos	Mochila ecológica en gramos	Consumo de minerales (T requerida por T Producida)	Consumo de agua (T requerida por T Producida)	Consumo de aire (T requerida por T Producida)	Consumo de energía primaria MJ/kg
Plásticos	60,75	13.061	4	207	4	99
Resina epoxy	7,06	2.188	14	290	6	83
Fibra de vidrio	4,87	501	6	95	2	15
Cristal líquido	4,75	76	3	12	1	15
Hierro	4,16	923	14	205	3	73
Aluminio	13,43	14.718	37	1048	11	194
Cobre	19,06	13.688	349	367	2	60
Oro	0,04	126.828	540.000	2.000.000	500.000	312.776
Plata	0,24	11.561	7.500	30.000	10.000	6.738
Silicio	0,87	14.733	2.000	10.000	5.000	6.738
Litio	1,17	42	6	20	10	314
Manganeso	9,93	2.114	17	194	2	0,25
Níquel	1,17	484	141	233	41	187
Grafito	9,34	3101	20	306	6	68
Electrolitos	11,68	1623	3	134	2	39
Otros (incluye tierras raras)	21,25	962.741	15.000	30.000	300	39
Total	169,77	1.168.741				

CRITICAL RAW MATERIALS: E-WASTE GENERATION

CRITICAL RAW MATERIALS: SOLUTIONS

In order of effectiveness:

- **Reducing**: Using fewer resources →*How often do you change your phone?*
- **Reusing**: Considering new uses (new lives) for things that are about to be disposed→ Have you ever bought a *second-hand phone?*
- **Recycling**: Following recycle rules (of the corresponding community) to enhance the recovery of different materials →*Where do you dispose your phone?*

17:00-18:00

Tutor

Christian Peña

Electric batteries

Electric batteries technologies

The battery of the electric vehicle consists of "Cell → Module → Package
A group of cells forms a module and a group of modules forms a package. Finally, in an electric vehicle, a form of battery is installed: a package.

e.g, in a BMW i3, a total of 96 battery cells are installed. Twelve cells are combined into one module and eight modules are joined together to enter the vehicle as a package.

The weight of an electric car battery is usually proportional to its energy capacity in kWh,
The truth is that this direct relationship does not always exist because of the energy density
A Tesla Model X with the 85 kWh battery would be equivalent to a 9-litre tank of petrol, weighing about 10 kg in total (the tank plus fuel). However, the Tesla Model X's batteries weigh 350 kg. we will can use about 78 kWh of 85 kWh

things to keep in mind!

How Many People Have Mobile Phones In The World?

4.78Billion
mobile phone users in the world today

61.28%
of people own mobile phones today

How many cars are there in the world currently?

It is estimated that **over 1 billion** passenger cars travel the streets and roads of the world today.
The 1 billion-unit mark was reached in 2010 for the first time ever.

In the United States alone, **268,799,083** "highway" registered vehicles were counted in 2016, of which **192,774,508** passenger cars. (Bureau of Transportation Statistics U.S. Department of Transportation)

Name of the initiative: **Raw materials key to our future**

This internship-like initiative has been promoted by my Institution …

Promote problem-based learning, self-organization and **learning by doing**
Facilitate access to experimental platforms for hands-on training
Offer online courses
Actively involve University, Industry and Professional Labs in education
Develop **Entrepreneurial skills**
Create **learning-by-doing Curriculum**

The following didactic approach has been pursued

Many students in high school are **using internships as a strategy to help decide their major**, bolster their college applications and **gain experience to better** prepare themselves

Under **close supervision and mentorship of professional staff**; undertakes one or more assigned activities and/or projects of fixed duration requiring a **basic degree of knowledge and skill within a defined area of RM**.

INITIATIVE DESCRIPTION

Duration of students involvement in the initiatives?

1. Early phase for the development of the activities:
- One week

2. The final phase:
- Two weeks

In which period of the year?

From may to june

How many students per year are involved?

1. Pilot phase – **15 students**
2. The final phase: aprox. **5 students**

How many Institution tutors per students are involved in the initiative?

1 per 3 students

Students recruitment procedure adopted by your Institution

To be considered for *admission*, *applicants* must meet the following requirements:

- Hold a minimum of a **4th year of high school** (16 or 17 years old)
- Field of secondary level in science and technology education
- Students with a **high interest** on Earth sciences and Circular economy

Specific scientific themes of internships

- **Mining activities:**

New innovative mining technologies and research to enable a sustainable, efficient and successful mining industry
now and in the future

- **Processing of primary and secondary resources:**

Improving, innovating and rethinking the processes and technologies involved can open up new business opportunities
which are more efficient and have less of an environmental impact

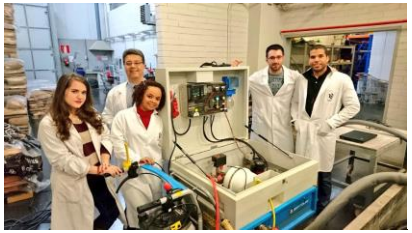
- **Modern-day solutions:**

Problems with Fluctuations in resource quality, the introduction of new resources, increased safety demands, environmental impact, and increasingly rapid changes in demands and markets

- **End-of-life-products**

Collaboration among Research organization/University/companies for the internship execution

LOM



Instituto Geológico y Minero de España

ATLANTIC COPPER
Una compañía del grupo Freeport-McMoRan

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Laboratorio Oficial para Ensayo de Materiales de Construcción

Output produced by students at the end of their internship

All the things the student can gain from a RM internship:

- **New and improved skills:** One of the most important things the students can gain from an internship is newfound knowledge.
- **Work hard no matter what you're doing:** Always work hard even **if your task is small and seems unimportant**. We help to the students **build a good work ethic**
- **Independence:** Being able to work independently with little guidance is very important in the working world
- **Increased self-confidence**
- **Enhances conventional classroom learning methods**

Internship is a great opportunity to gain experience, make friendships and learn!

Final event of the intership

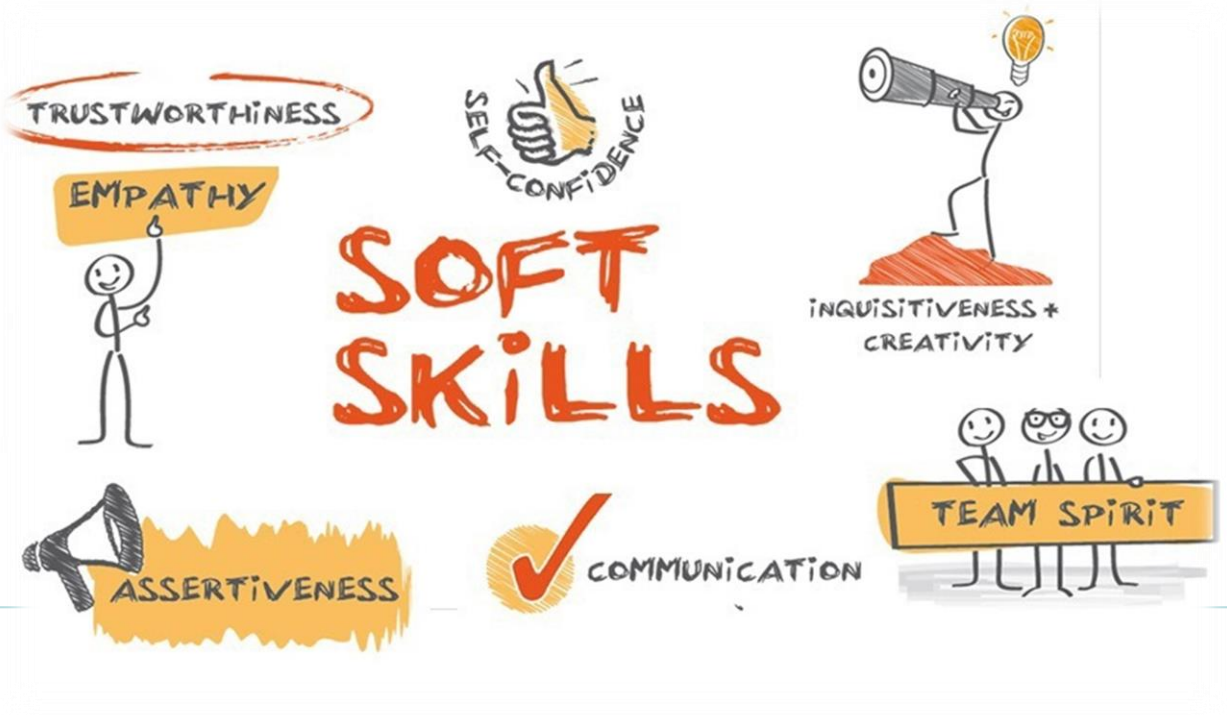
Interns look to their mentors and/or supervisors to help them **transition from the classroom to the "internship place".**
Mentors and/or supervisors **regularly meet with interns** to receive and provide feedback concerning their performance.
During these meetings the students may:

- Report on a project's status
- Participate in evaluating their strengths

Typically supervisors are asked to evaluate interns at the midpoint and end of the internship.
Company involved in the project are encouraged to review the internship with the intern before he or she leaves.
Evaluations are helpful when determining the intern's success within the organization for future internships.

Which kind of scientific/technical skill did students developed during the internships?

Societal skill?



Thank you for your attention.

Laboratorio Oficial J.M. Madariaga

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