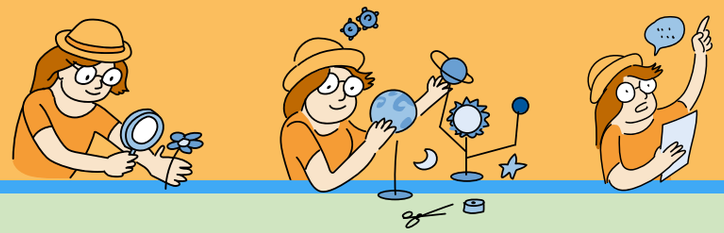
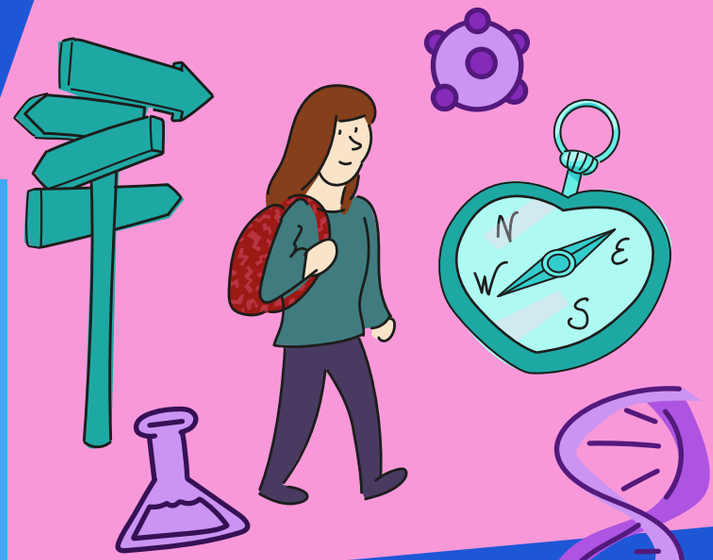
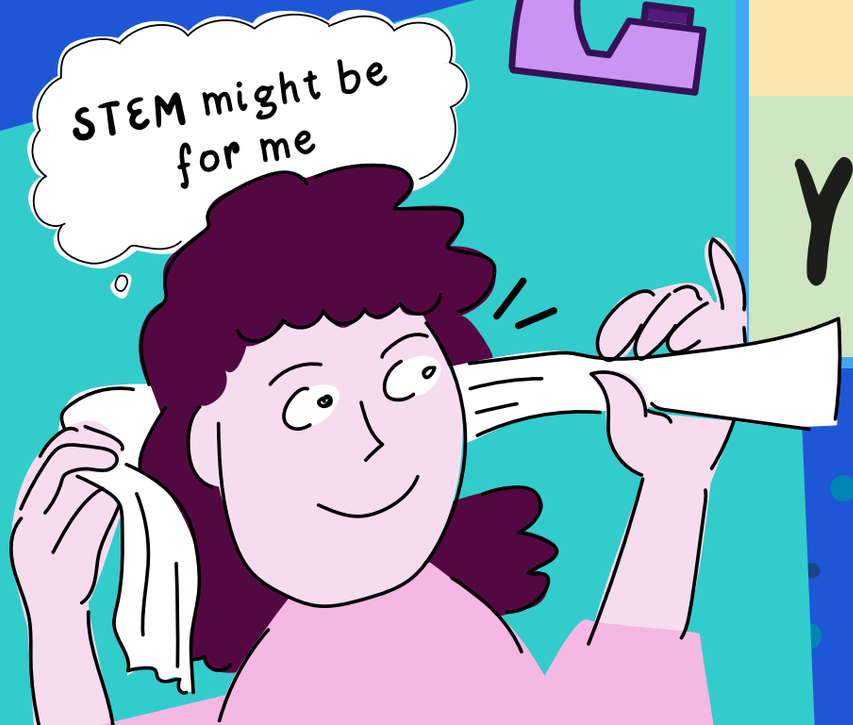
STEAM EDUCATION and STEM PROFESSIONS to inspire YOUNG PEOPLE







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Published by: Elhuyar

With the help of: Project subsidised by the Department of Economic Promotion, Rural Affairs and Territorial Balance of the Provincial Council of Gipuzkoa.

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This educational material has the approval of the Department of Education of the Basque Government: 29-10-2020.

The English version of this educational material has been co-funded by the Spoon project, Erasmus+ Programme of the European Union.

Legal Deposit: D 00253-2021

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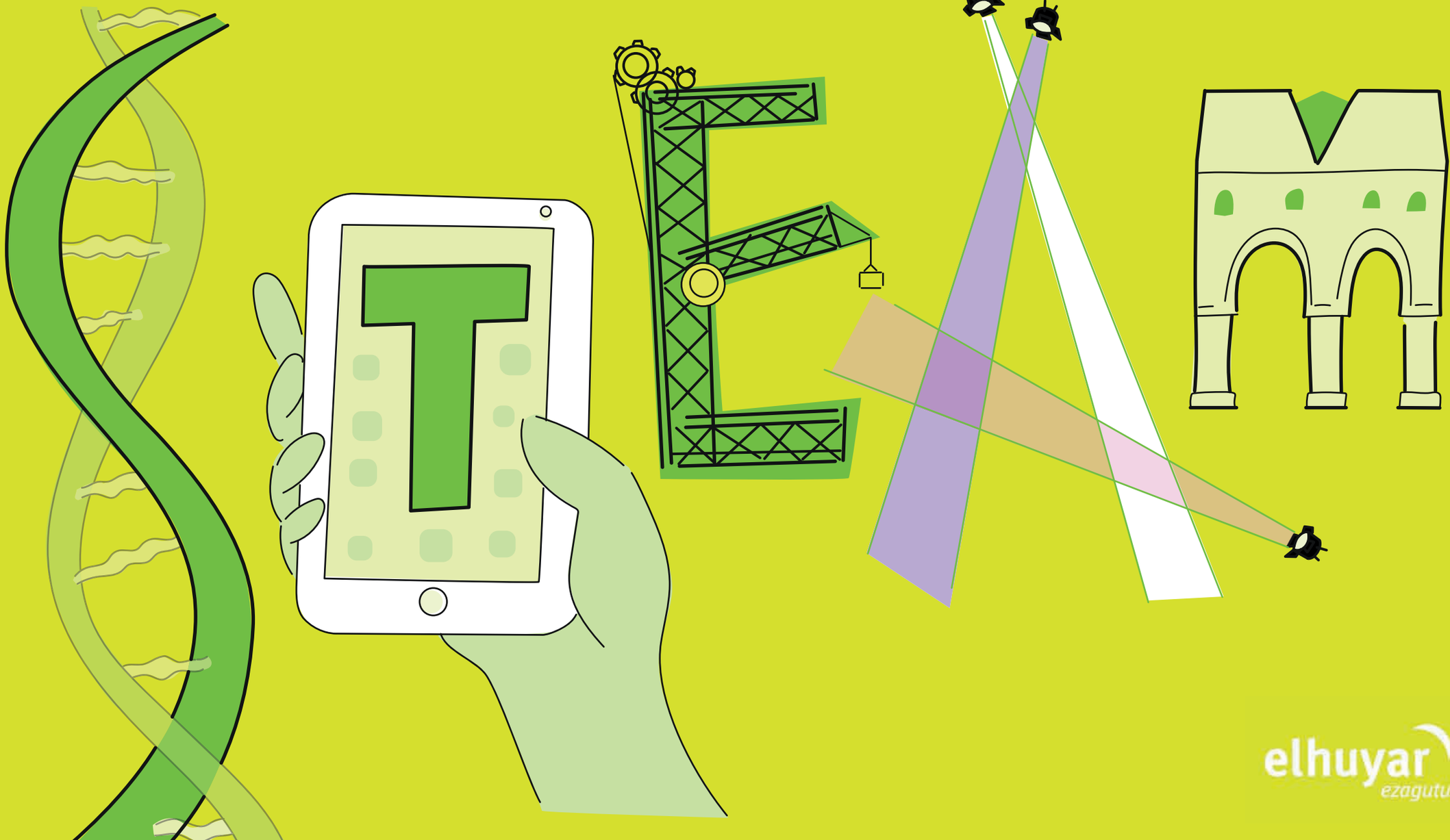
STEAM, MUCH MORE THAN AN ACRONYM



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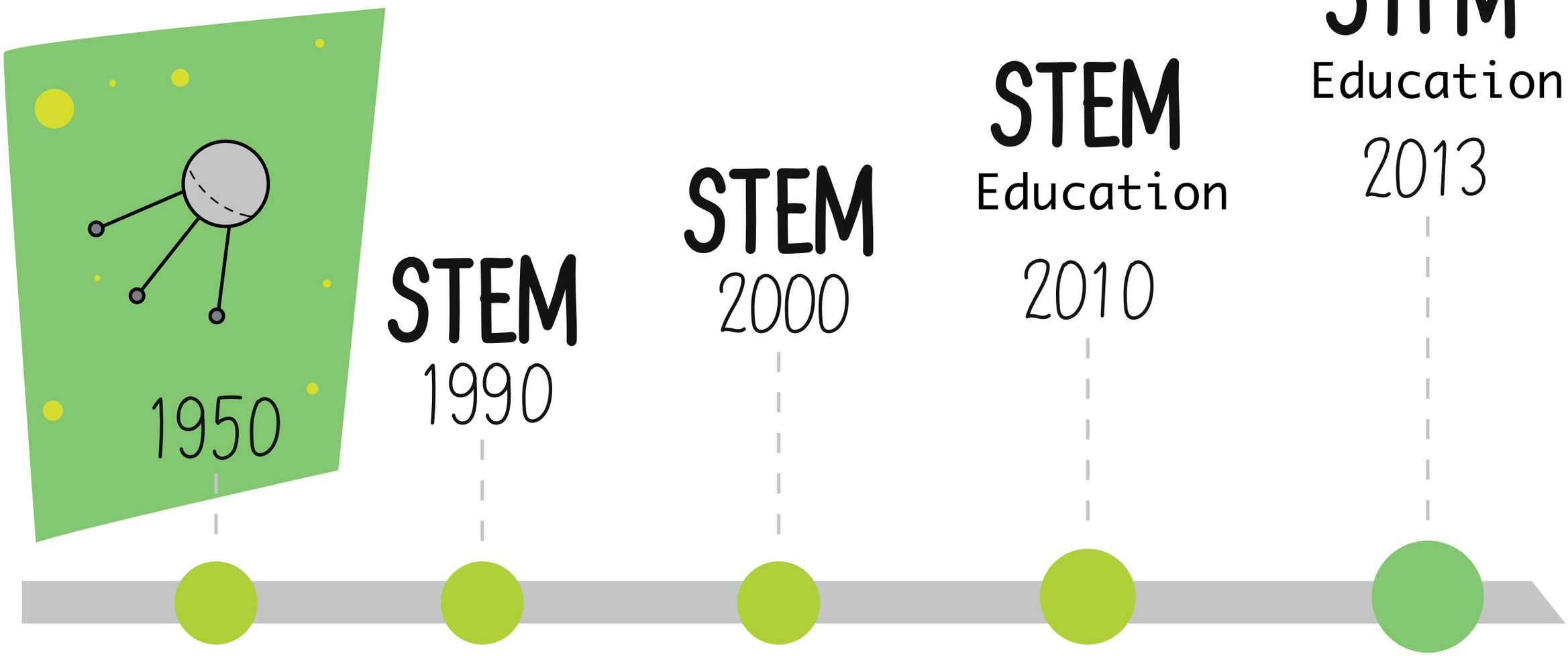
STEAM,
MUCH MORE THAN AN ACRONYM

- The origin of STEAM
- STEM and STEAM, some differences
- STEAM education
- STEAM education, myths

The origin of STEAM

From the 1950s to the present



Source: *Science and Mathematics Education Research Centre (CRECIM) of the Autonomous University of Barcelona (UAB).*

STEM and STEAM, some differences

STEAM: Science, Technology, Engineering, Arts, Mathematics.

The letter A, for Arts, has different meanings. Initially it stood for Arts, but it now represents the integrative perspective of all the disciplines.

STEAM education is focused on the practical application of theoretical knowledge. Thus, much importance has been given to the engineering perspective and to developing solutions to technological problems.

STEM professions: these are professions directly related to science, technology, engineering and mathematics. Health sciences and social sciences are sometimes included among STEM professions, and sometimes not.

What is STEAM EDUCATION

STEAM
Science
Technology
Engineering
Arts
Mathematics

RENEW EDUCATION

CONSTRUC-TIVISM

Project work

WOMEN...

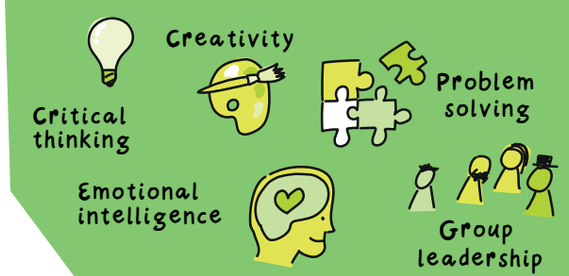
LEAVE SCHOOL

SHARED RESPONSIBILITY OF SOCIAL AGENTS

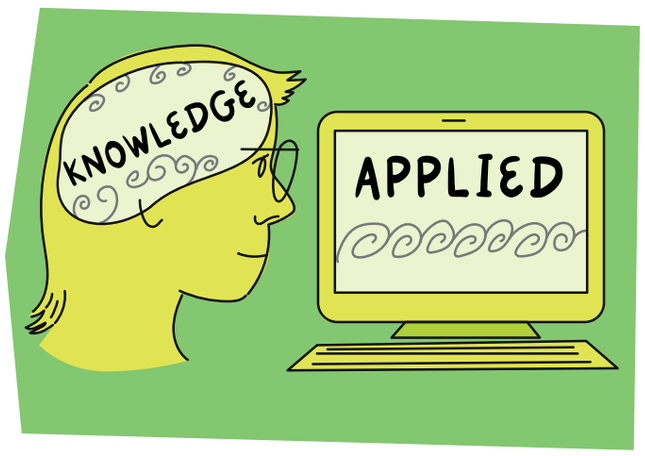
NETWORK DEMAND

THE STUDENT IS THE CENTRE

21ST-CENTURY SKILLS

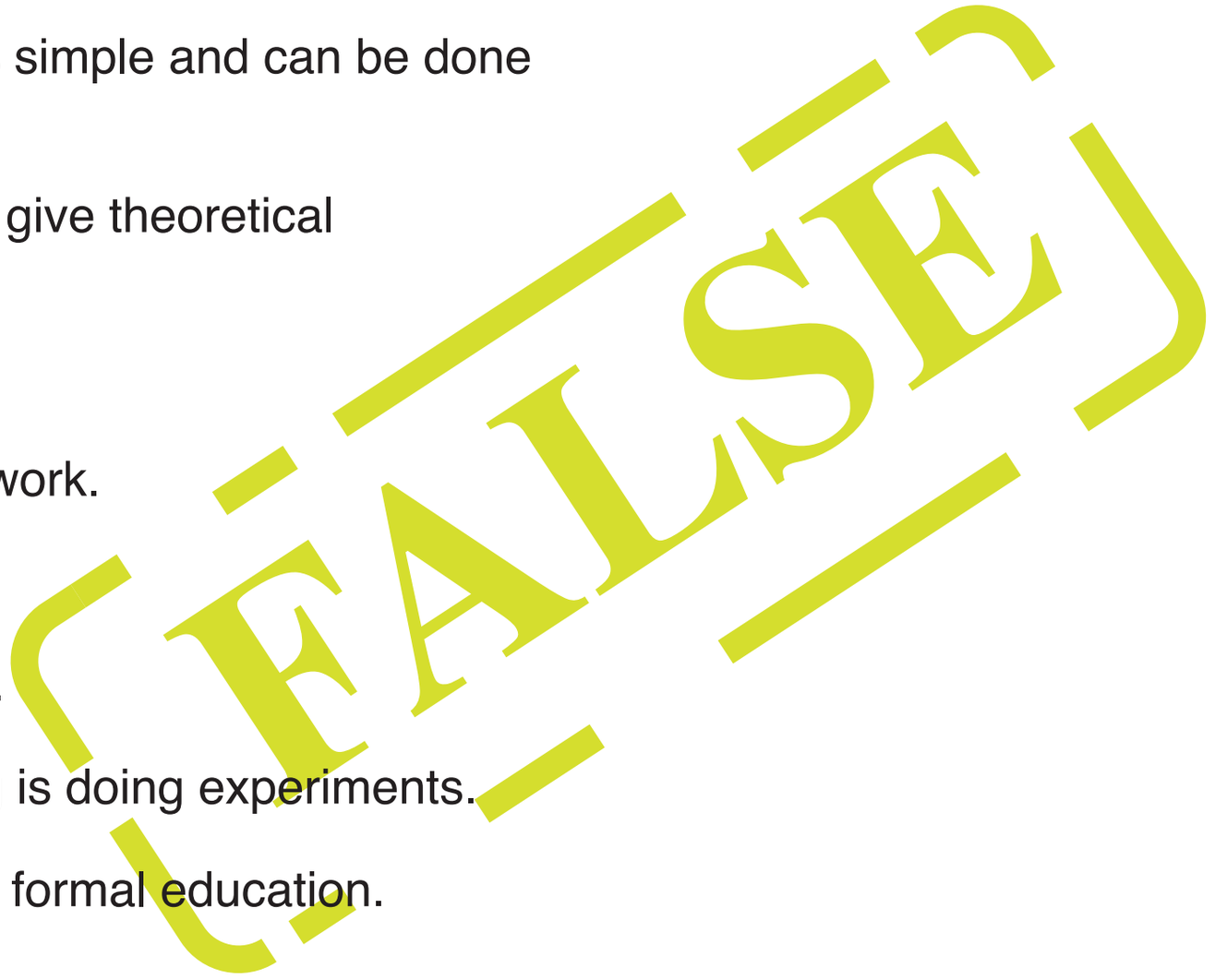


INTERDISCI-PLINARITY

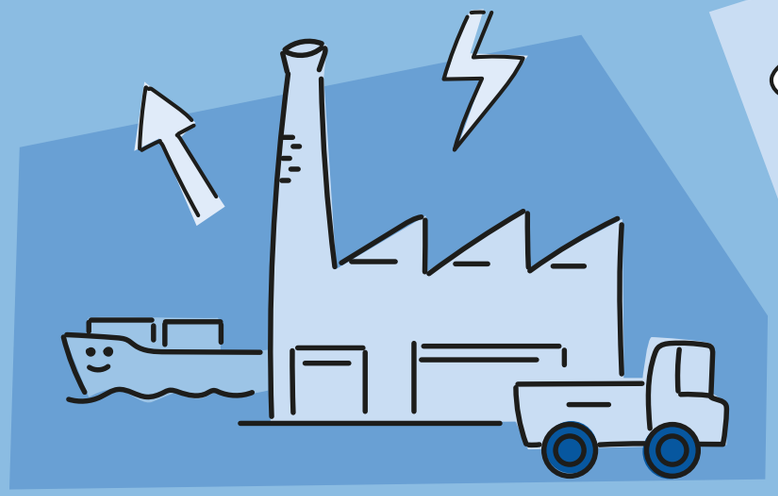


Myths about STEAM education

- ✗ STEAM education is nothing more than a change of methodology.
- ✗ For teachers, changing the methodology is simple and can be done immediately.
- ✗ With project work, teachers do not need to give theoretical explanations.
- ✗ STEAM is applicable to all disciplines.
- ✗ Students don’t learn as much with project work.
- ✗ All students prefer project work.
- ✗ Students have to work with total autonomy.
- ✗ With project work, the most important thing is doing experiments.
- ✗ Formative assessments are widely used in formal education.



WHY STEAM?



WHY STEAM?

- Objective: an active and critical community
- Need for STEM professionals in the future
- What do young people (from the Basque Country) say?
- A sustainable world through STEAM education
- Responsible research and innovation
- Experiences and community
- STEAM Euskadi strategy

Objective: an active and critical community

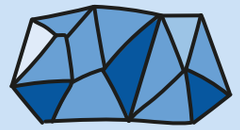

Students

Professional Center


Families


Experts


Society


Laboratories

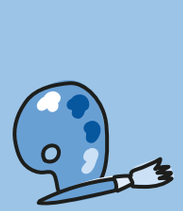

Universities

We need
MORE STEM PROFESSIONALS

Other types of STEM professionals
21ST-CENTURY SKILLS

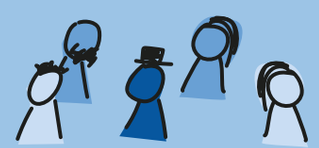

Problem solving

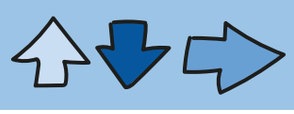

Critical thinking


Creativity

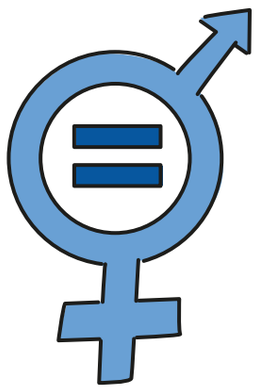

Caring


Emotional intelligence


Group management


Decision making

EQUALITY
between **WOMEN**
and **MEN**



in STEM occupations

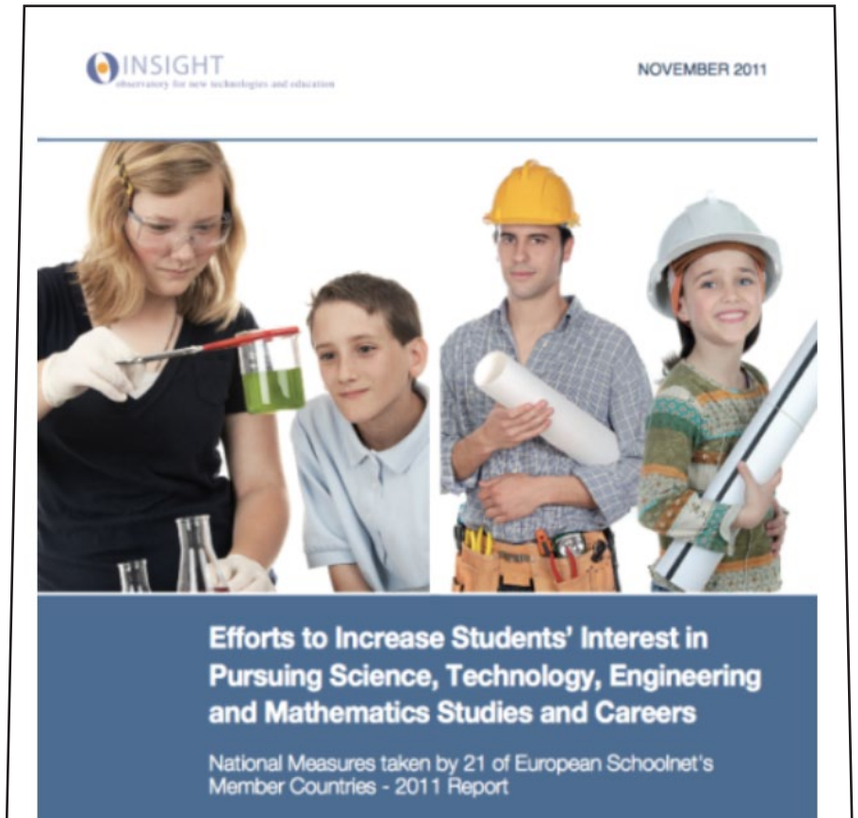
Facing the
CHALLENGES
of the world,

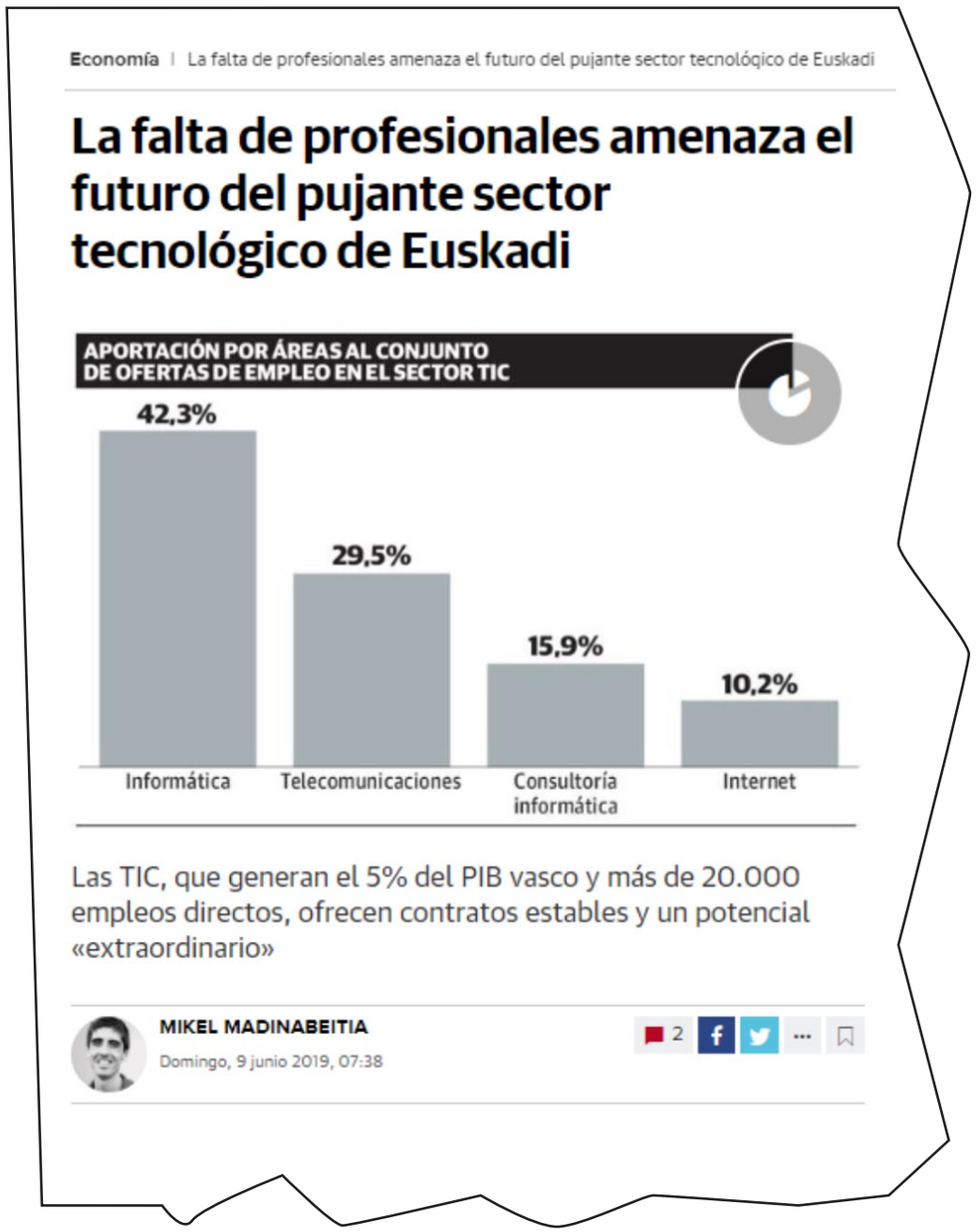
focusing
on **VALUES**

Need for STEM professionals in the future

Demand for STEM professionals

- **In the future, 80% of jobs will require STEM skills**
- **STEM professionals are needed in all economic sectors**
- **Need for professionals in the EU: ICT, doctors, STEM teachers, etc.**





Decline in STEM vocations

- Strict requirements for entry to university
- High dropout rate
- Low participation of women
- Brain drain" abroad or to other areas of work
- Low appeal
- Highly stressful work environments
- Fall in salaries

EL MUNDO OLGA R. SANMARTÍN Jueves, 19 diciembre 2019

EDUCACIÓN · Informe

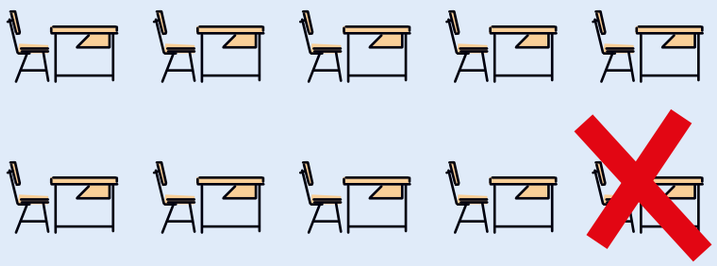
Los universitarios matriculados en carreras tecnológicas caen un 30% porque "no compensa el esfuerzo"

El presidente de los rectores advierte que "sin suficientes ingenieros, matemáticos, físicos o químicos nos quedaremos fuera de la Revolución 4.0 y seremos tecnológicamente dependientes"

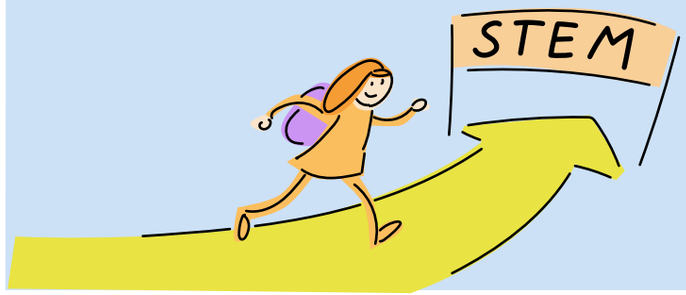
Alumnos de la Universidad Pompeu Fabra de Barcelona. EFE

Situation in the Basque Country

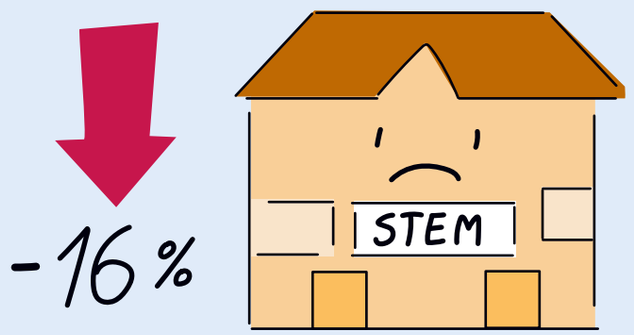
In 2030,
10% fewer children
in the classroom
(up to 16 years).



54%
of High School students choose scientific-technological training.



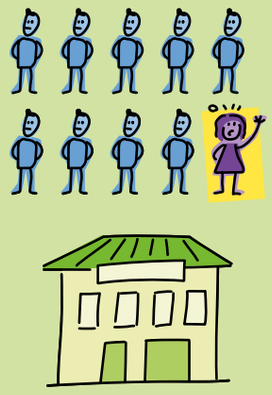
Since 2016,
16% fewer
students have enrolled
in STEM studies.



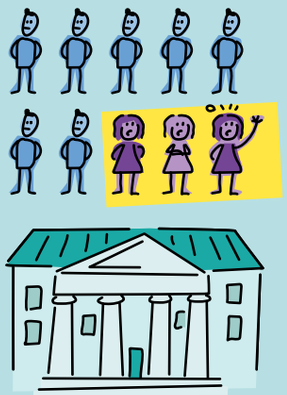
39% of vocational training and university students
obtain a STEM qualification

Female students in STEM disciplines:

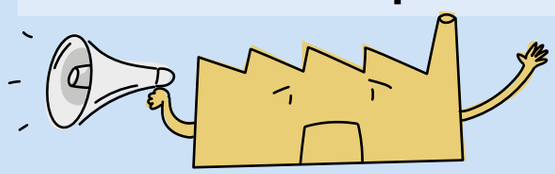
Vocational training,
9%
of the total.



University,
31%
of the total.



Between 2018 and 2020,
companies demanded more STEM profiles



From vocational training
56% +

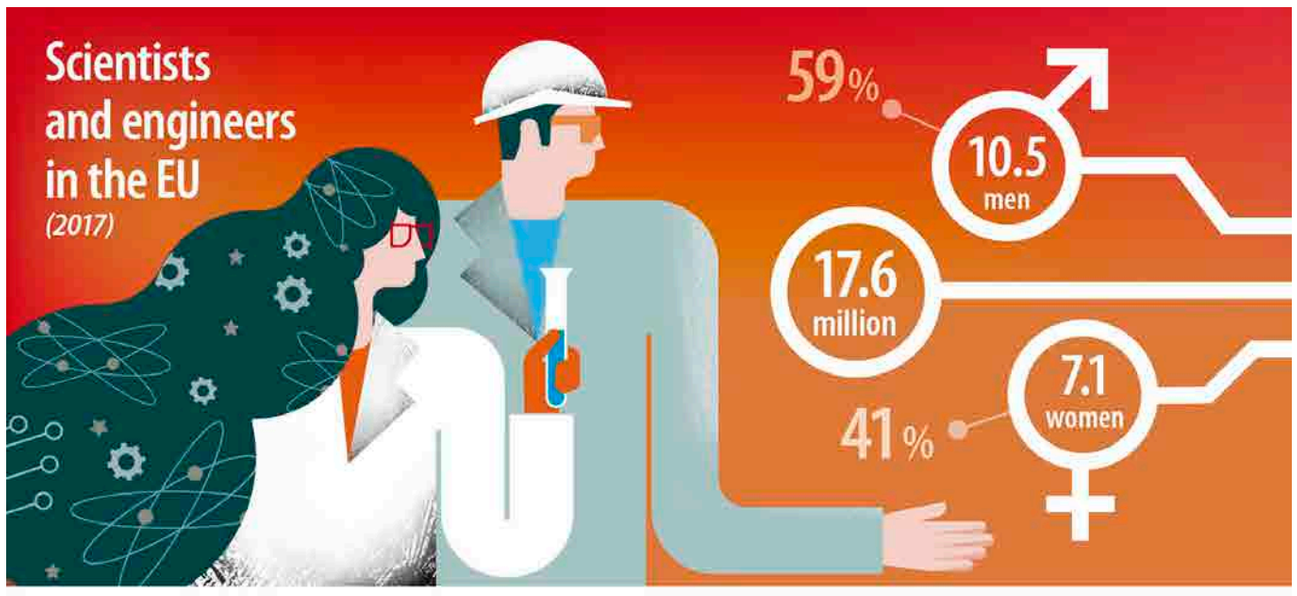
From university
25% +

STEAM in Europe

- **In 2017, 59% of scientists and engineers were men and 41% were women.**
- **Men were particularly overrepresented in high- and medium-level industrial manufacturing** (83% men)**, while the services sector was more balanced** (55% men and 45% women)**.**

- **However, in five EU member states, the majority of scientists and engineers were women:**
Lithuania (57%)
Bulgaria and Latvia (53%)
Portugal (51%) and
Denmark (50%)

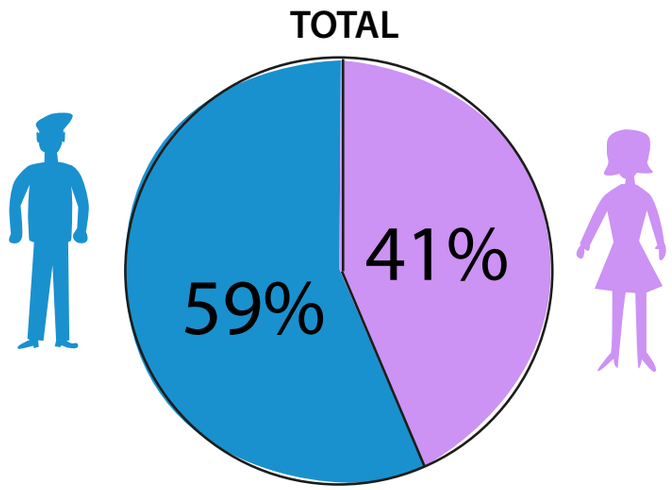
- **Women scientists and engineers accounted for less than a third in:**
Hungary and Luxembourg (25%),
Finland (29%) and Germany (33%).

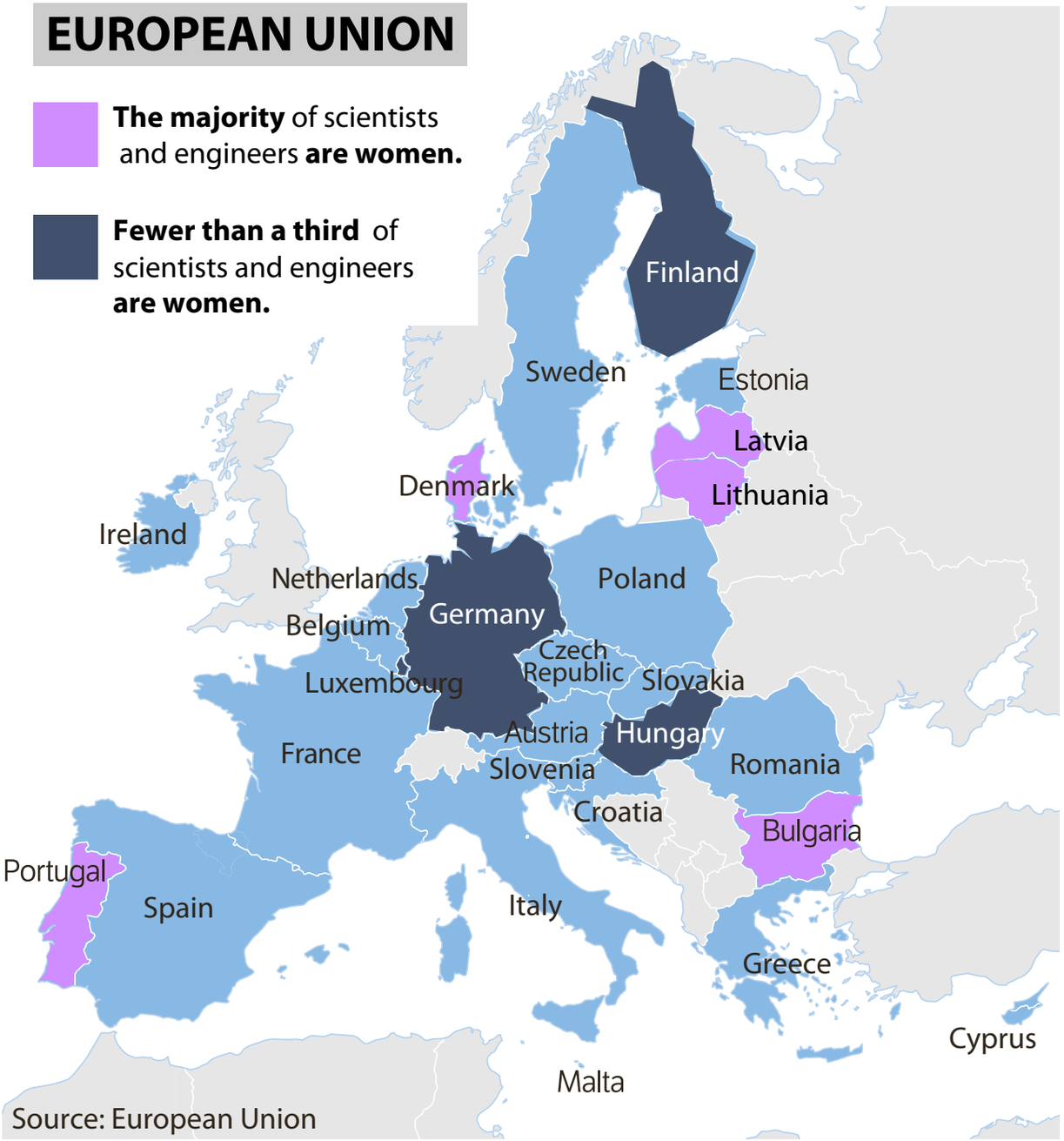


Source: *Eurostat.*

Women scientists and engineers

In 2017, 18 million scientists and engineers in the EU

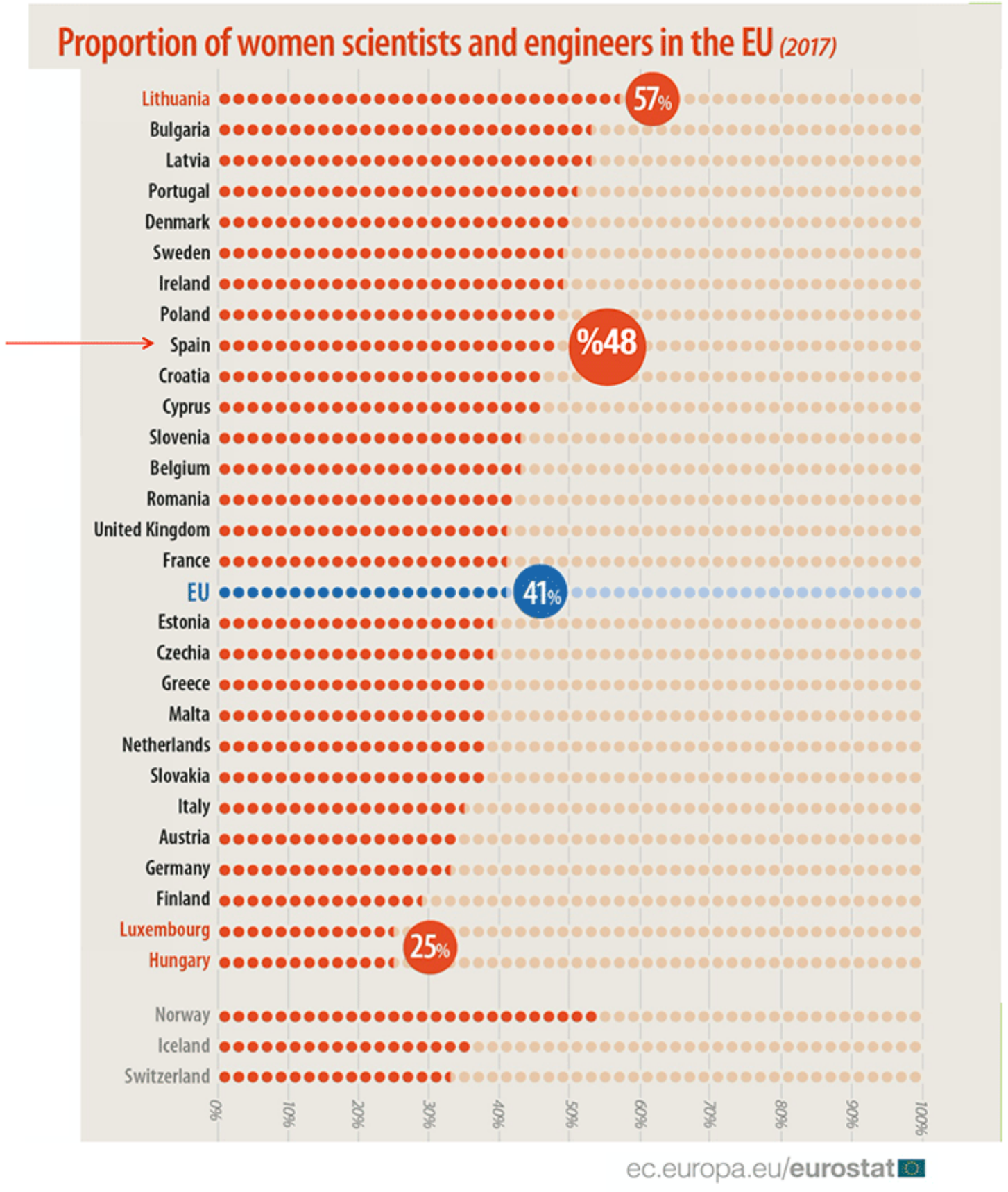




Source: *Scientists and engineers in the EU (2017). ec.europa.eu/eurostat.*

STEAM in Europe

Women scientists and engineers by country



Source: *Scientists and engineers in the EU (2017). ec.europa.eu/eurostat.*

What do young people (from the Basque Country) say?

Girls show more interest **in more subjects.**

Boys have **more focused** interests.

Half of young people **don't know the industry of the region**

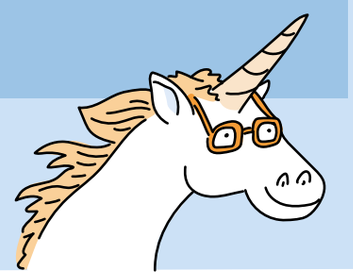
and they don't care.

Quality of life of STEM professionals

Stereotypes of STEM professionals

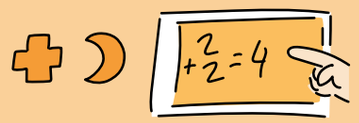
Hard-working
Wise
Intelligent
Very patient
Creative

Words to describe **good students!**



Gender stereotypes when choosing a profession

- **Girls:**
  Health Sciences
  and
  Teaching



- **Boys:**
  Technology

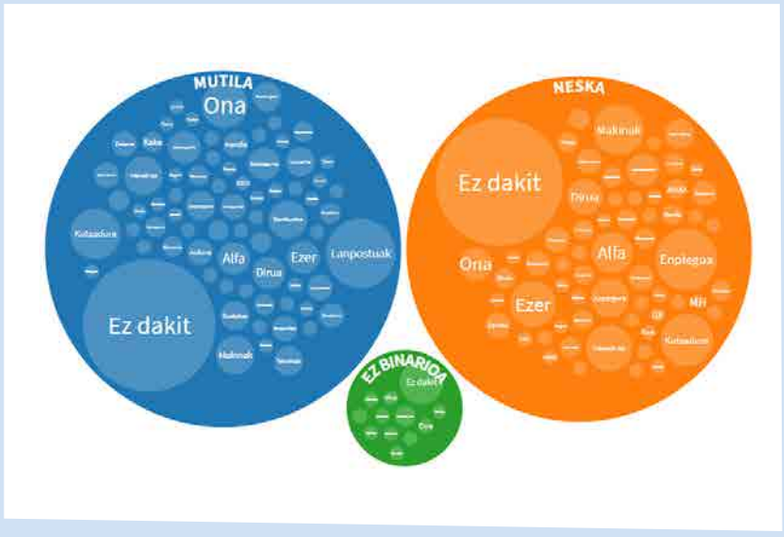
Young people **believe** that **working conditions in STEM are different** according to gender.

Note:
No global data has been extracted for non-binary people.

Source:
"STEAM arloko gaien eta lanbideen inguruko gazteen pertzepzioak". Elhuyar.

What would you like to be when you grow up?

Asked to describe in one word the main INDUSTRY OF THE REGION, the most common response was *"I don't know"*:
83 boys (31%),
76 girls (30%) and
9 non-binary (42%).



Key aspects for reflection and future research:

- Specialised jobs in the Basque Government's RIS Euskadi, primarily for boys?
- Do girls go into public administration?
- 84% of 3rd-4th year ESO are clear about what they want to study (and what they don't). (Everis)
- The main factor when deciding is the father or the mother, ahead of the media. (Everis)

A more sustainable world through STEAM education

UNESCO and Sustainable Development Goals

1. No poverty

Goal:
End poverty in all its forms everywhere

2. Zero hunger

Goal:
End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

3. Good health and well-being

Goal:
Ensure healthy lives and promote well-being for all at all ages.

4. Quality education

Goal:
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

5. Gender equality

Goal:
Achieve gender equality and empower all women and girls.

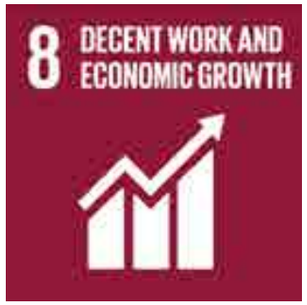
6. Clean water and sanitation

Goal:
Ensure availability and sustainable management of water and sanitation for all.

7. Affordable and clean energies

Goal:
Ensure access to affordable, reliable, sustainable and modern energy for all.

8. Decent work and economic growth



Goal:
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

9. Industry, innovation and infrastructure

Goal:
Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

10. Reduced inequalities

Goal:
Reduce inequality within and among countries.

11. Sustainable cities and communities

Goal:
Make cities and human settlements inclusive, safe, resilient and sustainable.

12. Responsible consumption and production

Goal:
Ensure sustainable consumption and production patterns.

13. Climate action

Goal:
Take urgent action to combat climate change and its impacts.

14. Life below water

Goal:
Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

15. Life on land

Goal:
Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

16. Peace, justice and strong institutions

Goal:
Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

17. Partnerships for the goals

Goal:
Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development.

Technology is more accessible

Moreover, we must consider the factor of commercialisation of consumer technologies.

Responsible research and innovation

Six action lines have been established for Responsible Research and Innovation (RRI):

• **Ethics.** Focuses on the ethics of science. Its aim is to prevent unacceptable practices and to work for the ethical acceptance of scientific advances.

•

Governance. Responsibility must be shared among all. For this, society must be offered instruments of governance that make shared responsibility a reality.

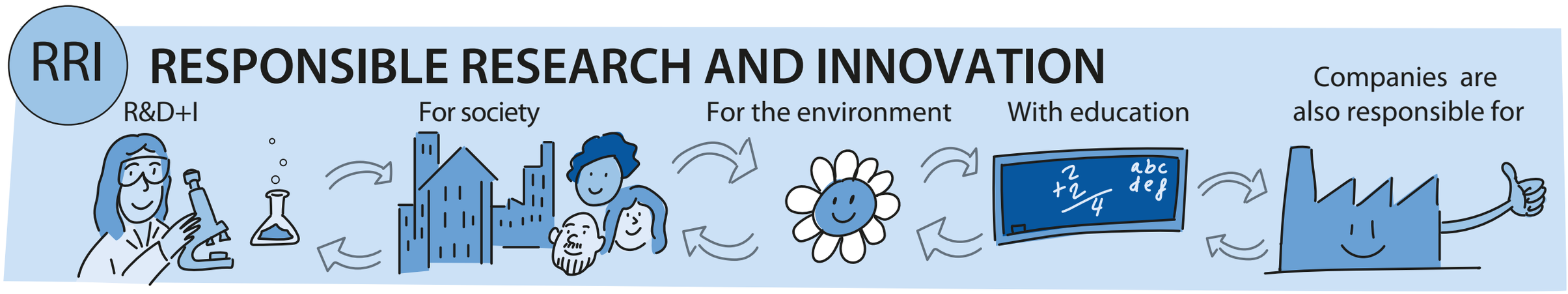
• **Science education.**
Science education must be improved so that citizens can make decisions, by working on vocations.

• **Gender equality.**
Promote gender equality in research groups so that decision-making bodies accurately reflect society.

• **Free access to data.**
Free access to science, to provide more opportunity for interacting and developing together.

• **Citizen participation.**
Promote citizen participation throughout the research process, so that the results are more aligned with the values, needs and desires of society.

See ZientziaKIDE.



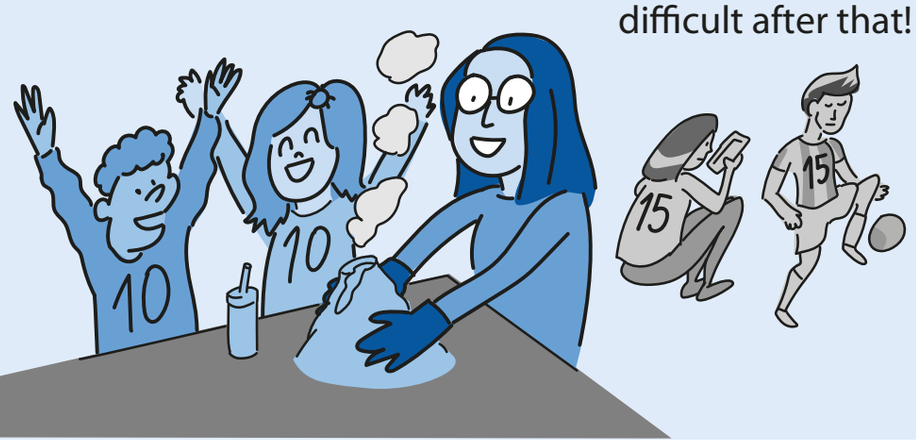
Experiences and community

With regard to choosing studies, according to research by **Aspires**:

Liking STEAM **is not enough.**

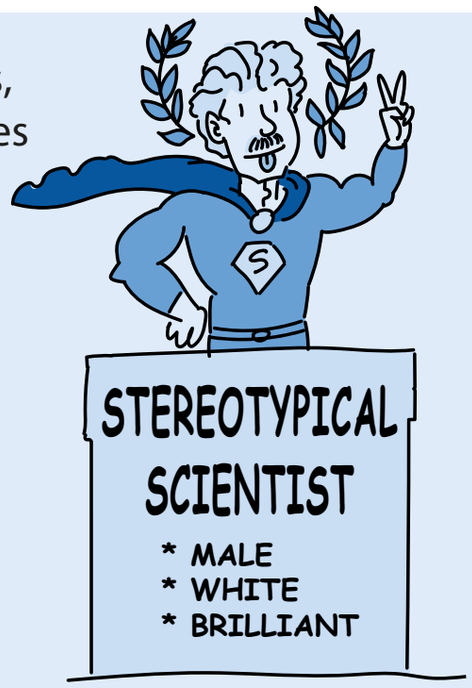
Key age for working on vocations:
10-14 years.

Increasingly difficult after that!



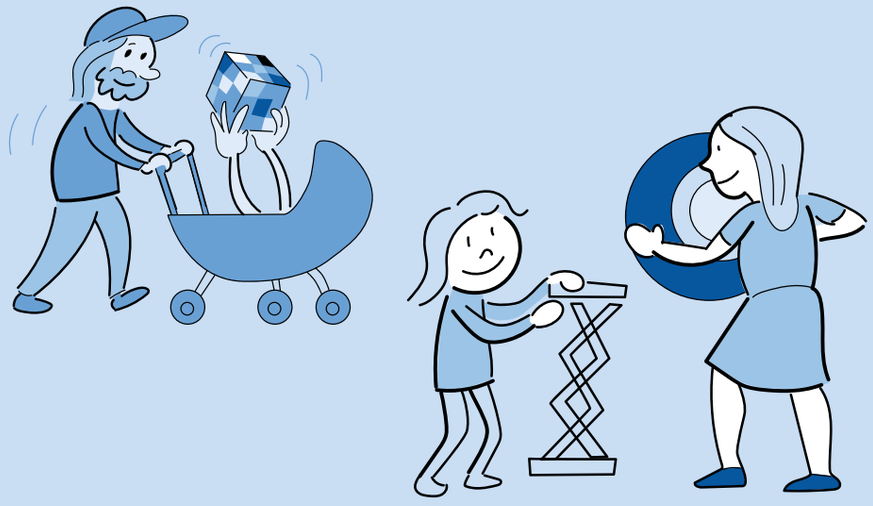
Studying STEAM
is not just for being
a scientist.

Prejudices, stereotypes and **false beliefs** about science.



To empower young people, give them a **realistic** view of STEAM content.

The importance of the **family** and the **social environment** in increasing **scientific capital.**



...CREATE EXPERIENCES!

The factors that influence the choice of STEAM studies are divided into five groups (see **Ingenious**):

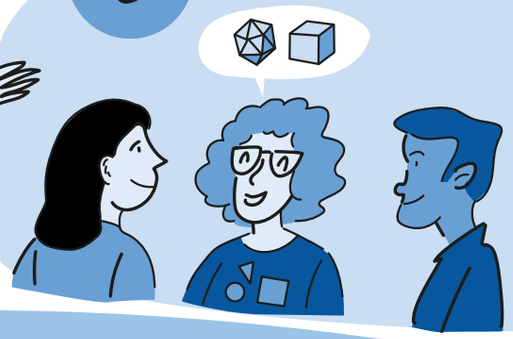
1 Personal environment

- Avoid false beliefs.
- Self-perception.
- Overcome the narrow view of science.

2 Family environment

- Science capital of family members.
- STEM workers in the family.

3 Social environment



Scientific perspective in leisure products and in the media.

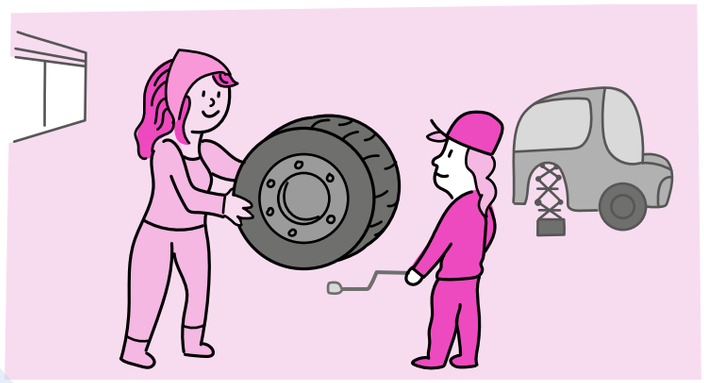
5 The economic context

4 Educational environment

- Teaching methodologies.
- Orientation in education.

...involve the whole **COMMUNITY**

Creating STEAM experiences



with the support of the whole community

EXPERIENCES AND COMMUNITY

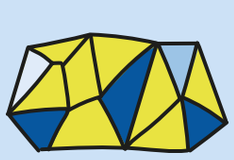

Students

Professionals


Families


Experts


Society


Laboratories


Universities

STEAM Euskadi strategy

- **steam.eus**

- **Educational and professional strategy of the Basque Government.** Presented in June 2018.

- Combines science, technology, engineering and mathematics with arts and the humanities**, with an emphasis on interdisciplinarity.**

Education based on key STEM skills and transversal skills.

- **Seeks to empower students to meet the challenges of our society.**

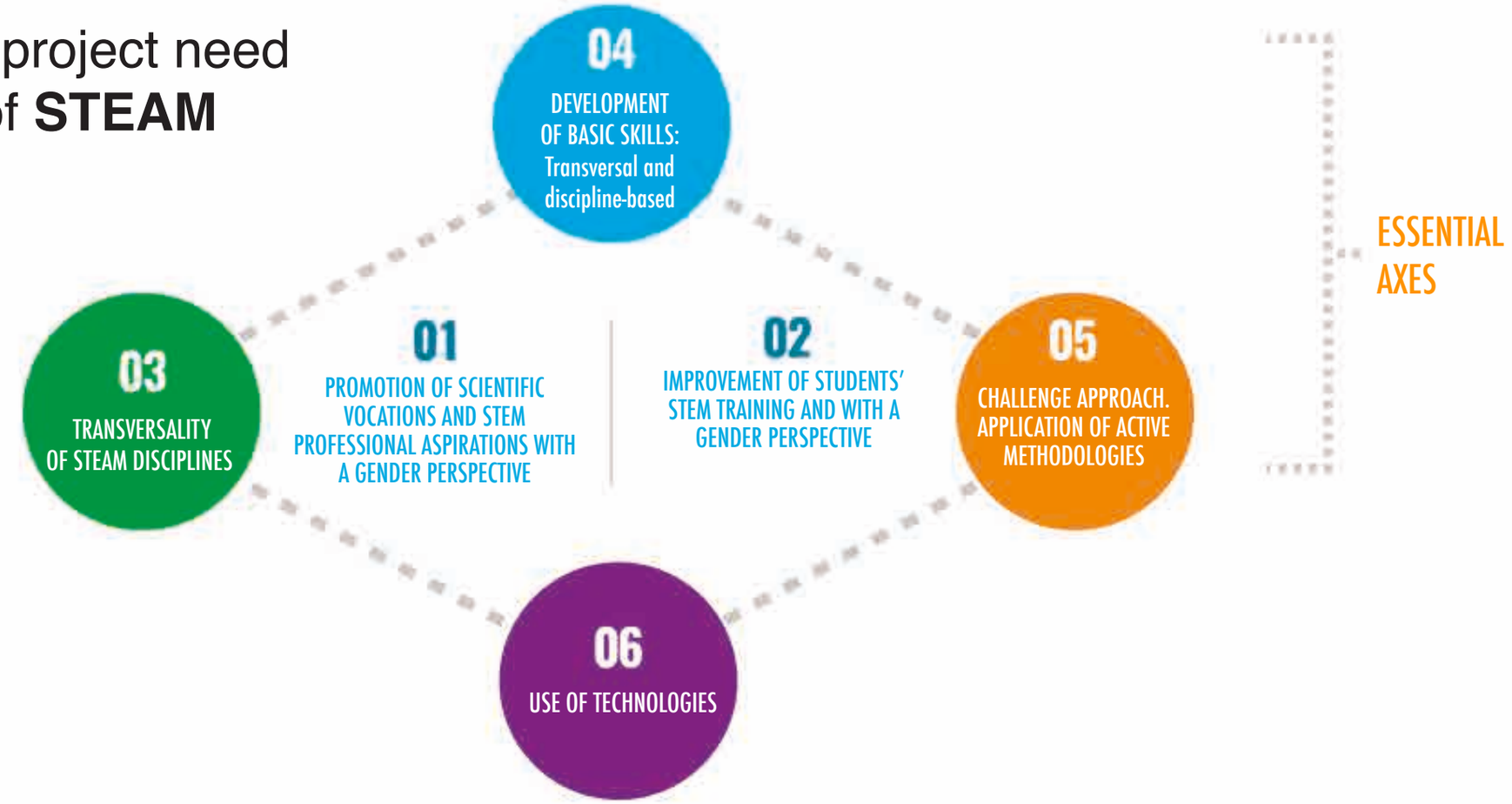
Objectives of the STEAM Euskadi strategy:

1.- To promote scientific and technical education and foster partnerships and collaborative work with socio-economic agents.

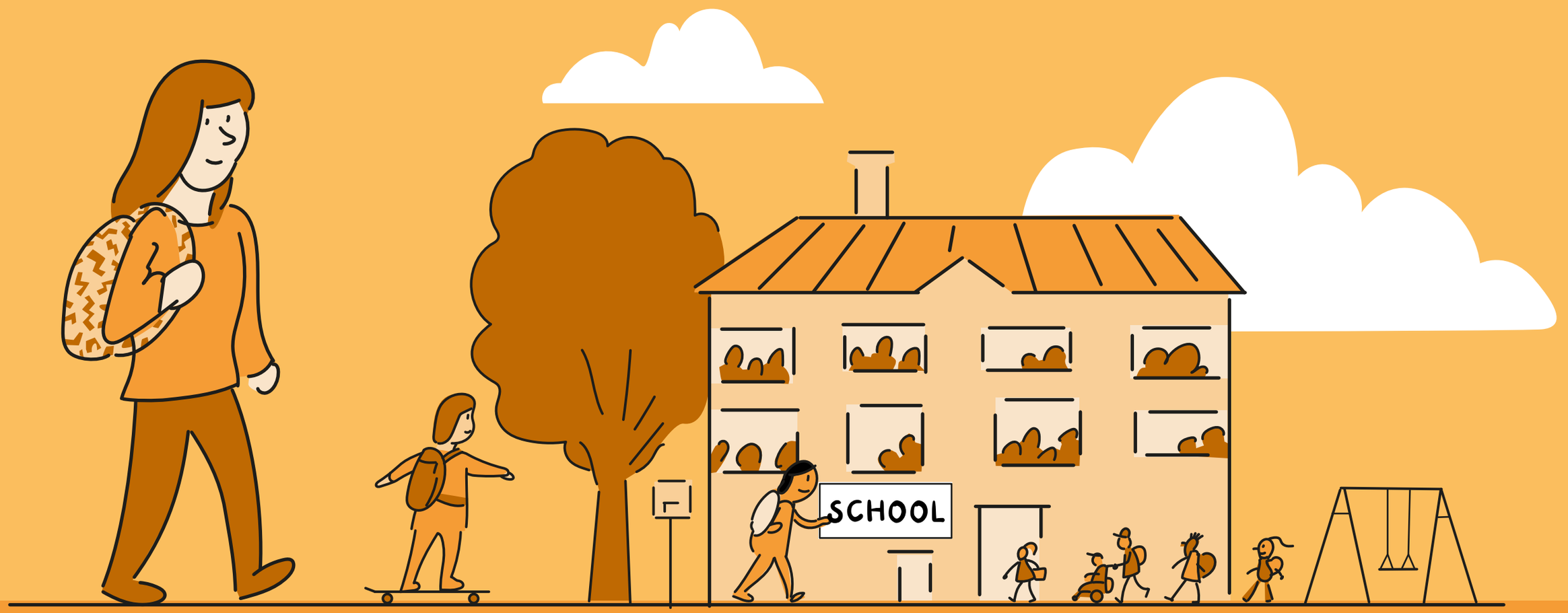
2.- To encourage professional aspirations in the STEM field, with a particular focus on gender.

3.- To promote scientific and technological culture among citizens.

What does a project need to form part of **STEAM education?**



STEAM EDUCATION IN SCHOOLS



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STEAM EDUCATION IN SCHOOLS

- Knowledge of science.
- What do we need to know about science?
- What does the research say about science education?

Schools in the Basque Country.

- STEAMGUNEA.

Science knowledge

Science is an intellectual creation for analysing nature.

SCIENCE OF SCIENTISTS

Knowledge + Theory + Methodology + + Thought

LABORATORIES OF SCIENTIFIC PERSONNEL

Spaces designed for asking questions, for research and innovation.

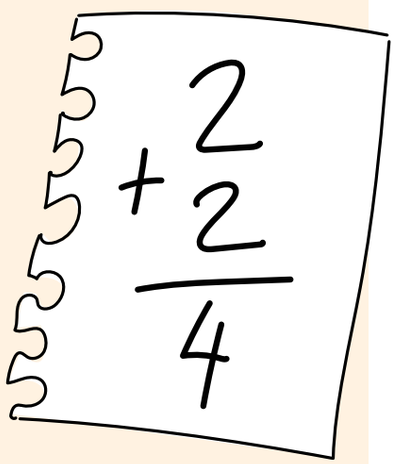
SCIENCE IN SCHOOL

Presented as a seamless truth.

Theoretical knowledge.

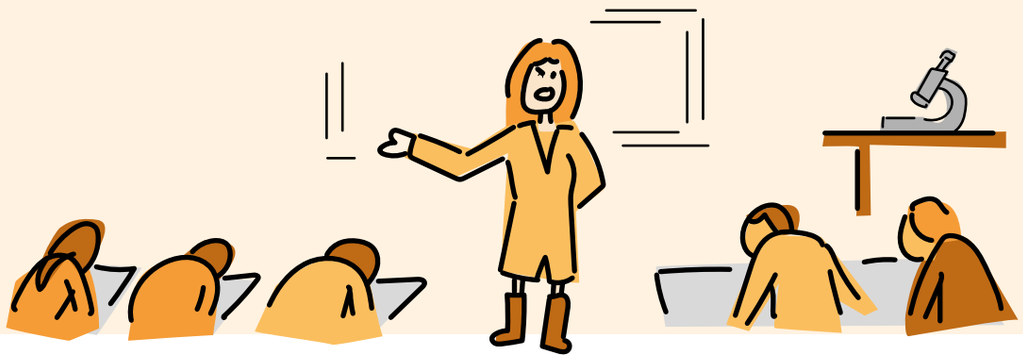
Often focused on numerical exercises.

Mistakes made in the past usually not shown.



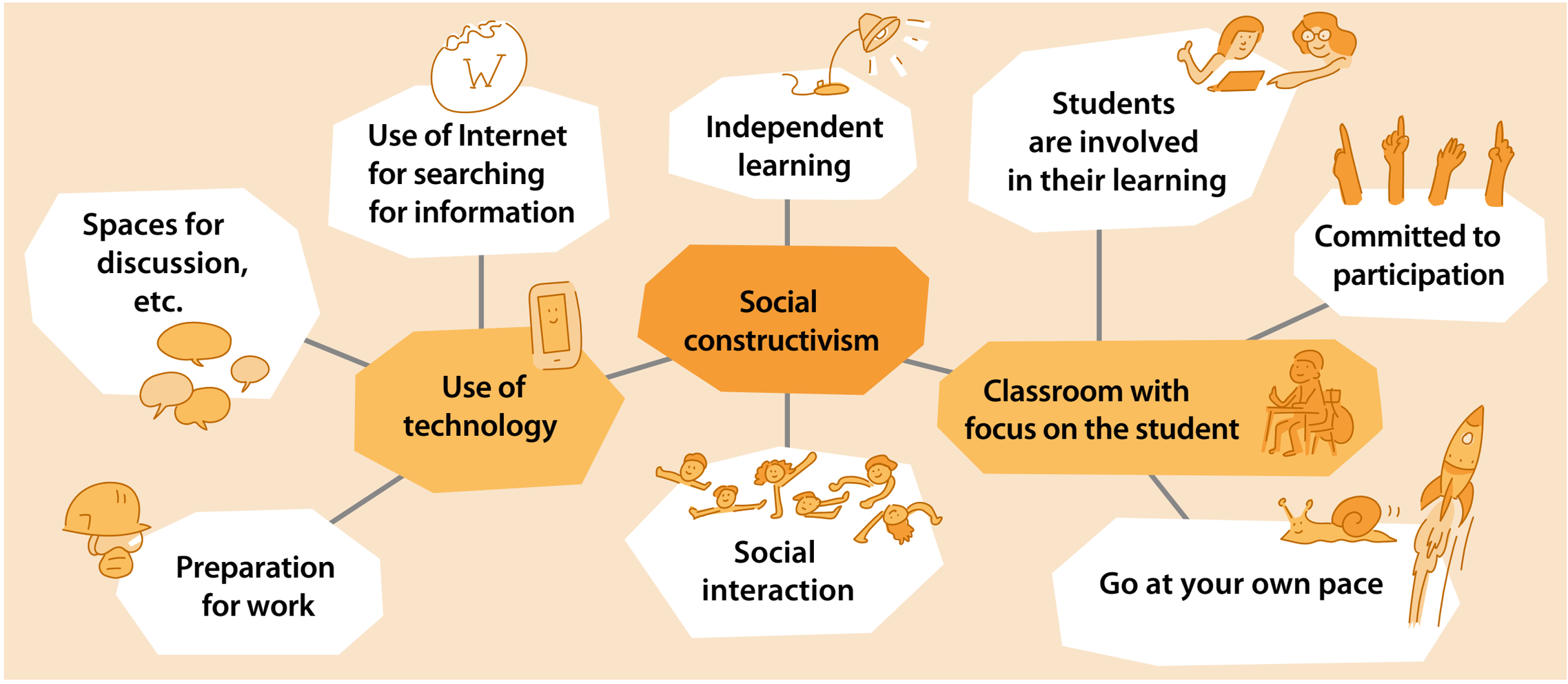
SCHOOL LABORATORIES

The teacher's knowledge takes priority over the students' questions.
There is little room for critical thinking.
More dogmatic.



Knowledge of science

According to the latest trends, the most important aspect is the **ability to understand**, and not knowledge in itself.



What should science in schools be aimed at?

Providing an intellectually, socially and academically attractive classroom environment that encourages students to ask reflective questions.

For more information: Chin and Osborne, 2008.

What do we need to know about science?

10 principles of science education

1. At all stages of compulsory education, through its science education programmes, the systematic goal of schools should be to develop and maintain the students' curiosity about the world, to ensure that they enjoy science activities and that they understand natural phenomena.

2. The overall objectives of science education should be the participation of everybody in informed decision making and in actions that contribute to individual well-being and that of society and the environment.

3. Science education has several objectives, and should develop the following:

a. An understanding of the 'big ideas' of science, including the role of science and scientific ideas in society.

b. Scientific skills for obtaining and using evidence.

c. Scientific attitudes.

What do we need to know about science?

4. On the road to a science education, a clear path should be established, indicating the ideas that need to be achieved at each stage, the concepts that need to be worked on, and carefully analysing current research to help us understand how students learn.

5. Progress towards great ideas should be the result of researching topics that are meaningful to the students or for their lives.

6. Learning experiences should reflect the view of explicit scientific research in line with current scientific and educational thinking and scientific knowledge.

7. All activities in the science curriculum should deepen the understanding of scientific ideas, and should also have other aims, such as developing scientific attitudes and skills.

What do we need to know about science?

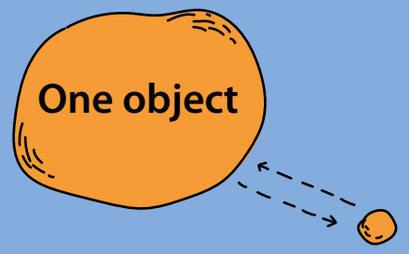
8. The programmes, initial competences and professional development of teachers guiding student learning should be consistent with the learning and teaching methodologies set out in the objectives of the 3rd principle.

9. Assessment plays a key role in science education. A formative assessment of student learning and a summative assessment of student progress should be applied to all objectives.

10. To achieve these objectives, school science programmes should promote peer support among the teachers as well as community involvement, including that of scientists.

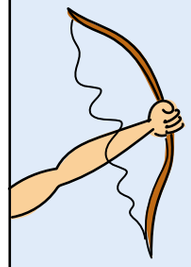
Big ideas of science

Everything **MATTER** in the Universe is made up of tiny particles.



can affect another object from **far away.**

For an object to change its motion



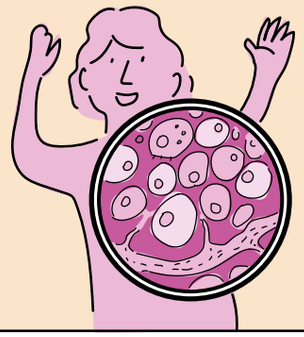
it must be **acted on by an external force.**

The universe always has **the same amount of energy,** but the energy can be transformed if something is changed or caused.

The composition of the Earth and the atmosphere, and the phenomena that occur in them,

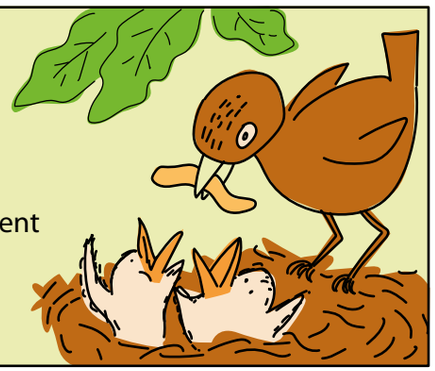
shape the Earth and influence **its climate.**

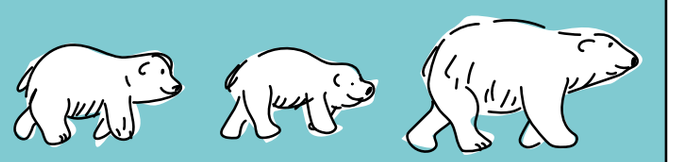
The solar system is a small part of one of the billions of galaxies in the universe.



Organisms are made up of **cells.**

Organisms require **energy** and **materials;** and are often dependent on and compete with other organisms for them.





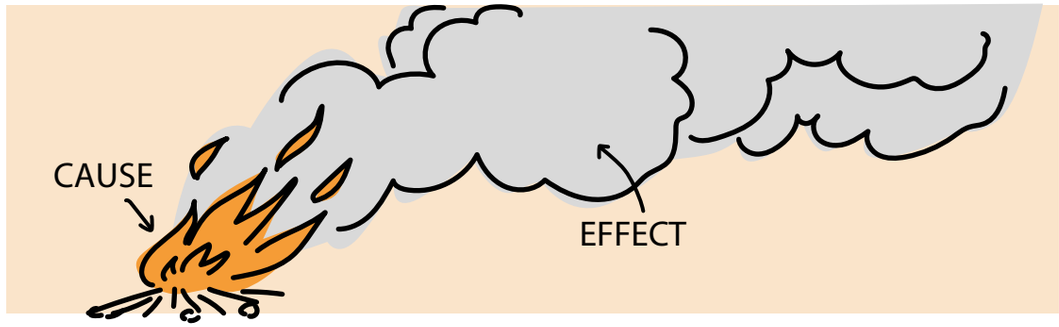
Genetic information is passed from one **generation** of organisms to the next.

The **diversity** of living and extinct organisms is the result of evolution.

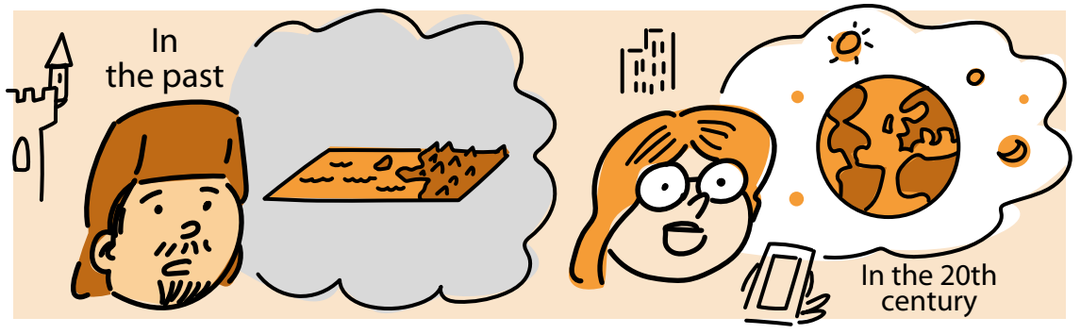
What do we need to know about science?

Ideas about science

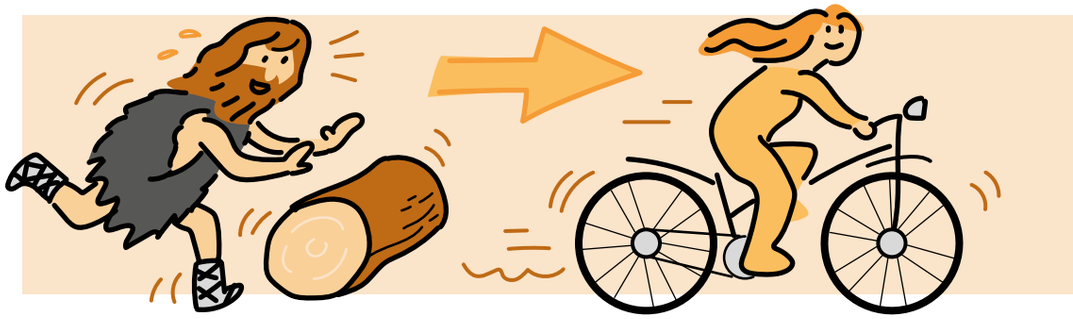
1. Science considers that there is one or more causes of the same effect.



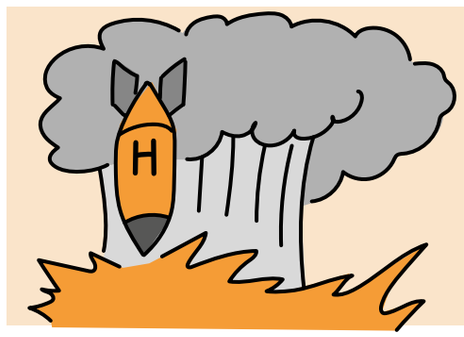
2. Scientific explanations, theories and models provide the best way to explain the facts known at a given time.

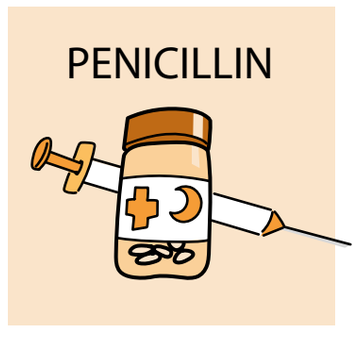


3. Scientific knowledge is applied in some technologies to create products that meet the objectives of humans.



4. Scientific applications often have ethical, social, economic and political consequences.





What does the research say about science education?

Enseñando ciencia con ciencia *(Teaching science with science)*

https://www.fecyt.es/es/publicacion/ensenando-ciencia-con-ciencia

February 2020 edition; published by FECYT and the Lilly Foundation
Coordinators: Digna Couso, M. Rut Jiménez-Liso, Cintia Refojo and José Antonio Sacristán.

Enseñando ciencia con ciencia seeks to emphasise the need to connect science teaching practice with the abundant scientific research in this field. This interdisciplinary body of research, which brings together results from neuroscience, the psychology of learning, pedagogy and, above all, science education, provides us with scientific evidence and consensus on what we know currently works or does not work in science teaching and learning. The best way to learn science is to practice how it is done, and through discussion and reflection in the classroom.

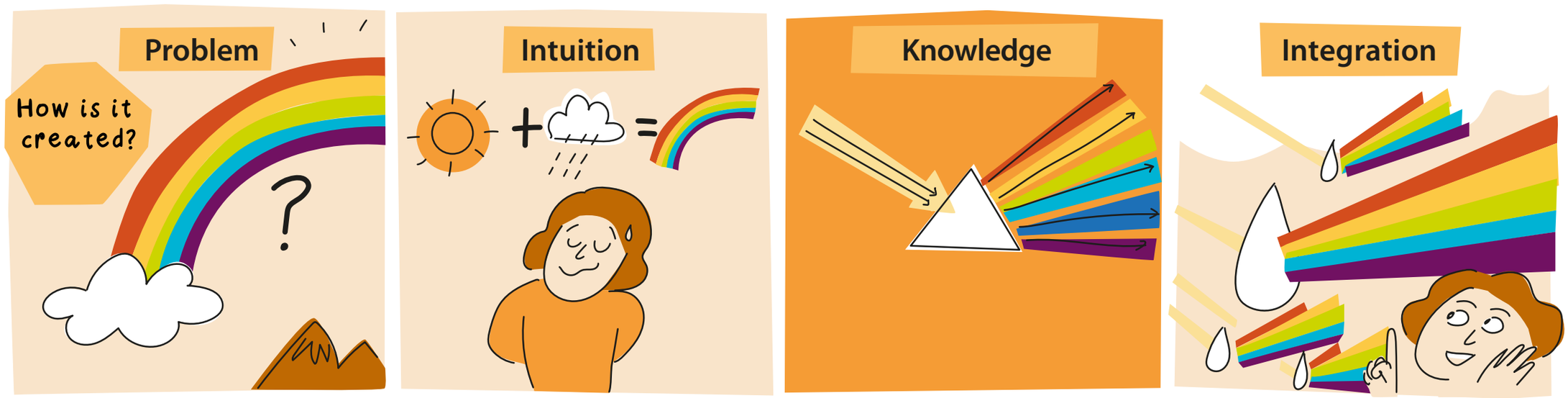
1. **Learn science by questioning ideas.**
2. **Advantages of cooperative learning.**
3. **Research, modelling and argumentation.**
4. **Teaching science to form free citizens.**
5. **Teach science without gender stereotypes.**
6. **Use controversial issues in the classroom.**
7. **“Neuromyths" in teaching and at work.**

1. Learning science by questioning ideas

• Teaching science should help not only to explain personal or intuitive beliefs, but also to reconstruct or change beliefs through a dialogue with other more complex ways of knowing and thinking.

• In order for students to question their intuitions, they should be presented with problems, new situations that they cannot predict correctly, and be required to explain and make sense of their intuitions.

• To help students change their intuitive science, they must not be forced to abandon it because it is wrong, but rather to reconstruct it through dialogue with scientific knowledge, in a process of integration of knowledge.



2. Advantages of cooperative learning

• When group work results in real cooperation with peers, it produces better learning, not only in terms of social relations, but it also improves understanding and more autonomous learning.

• It is not enough just to have the students work in groups; cooperation must be encouraged through specific teaching strategies.

Myths about group work:

✗ Group work dilutes individual responsibility and only those who are the most interested learn.

✗ It is enough just to have the students work in groups for them to learn cooperatively.

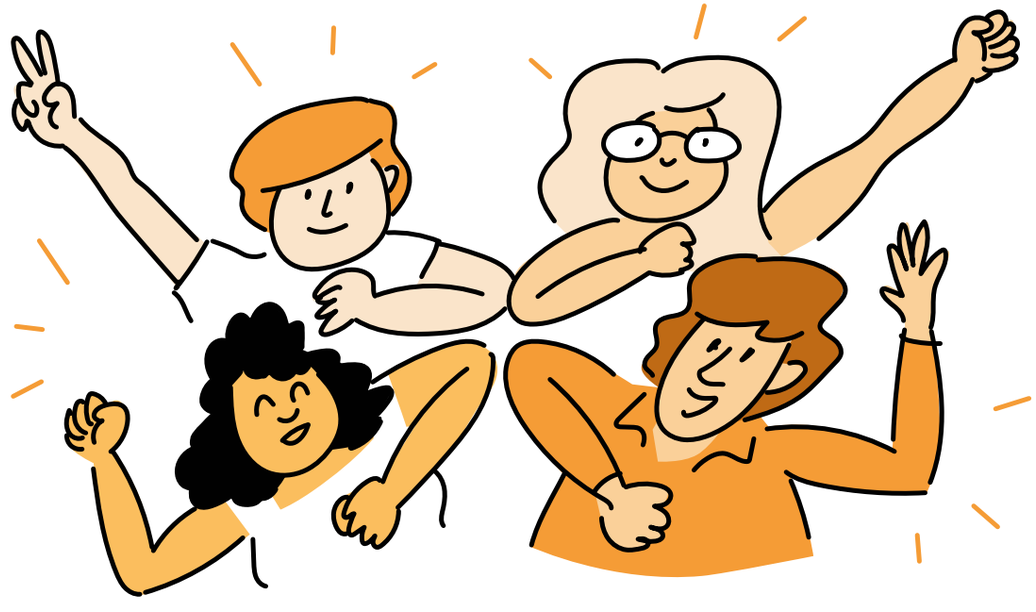
✗ It is better to form homogeneous groups of the same level, as they can progress together.

FALSE

Advantages of cooperative learning

Some ideas for encouraging cooperation in group work

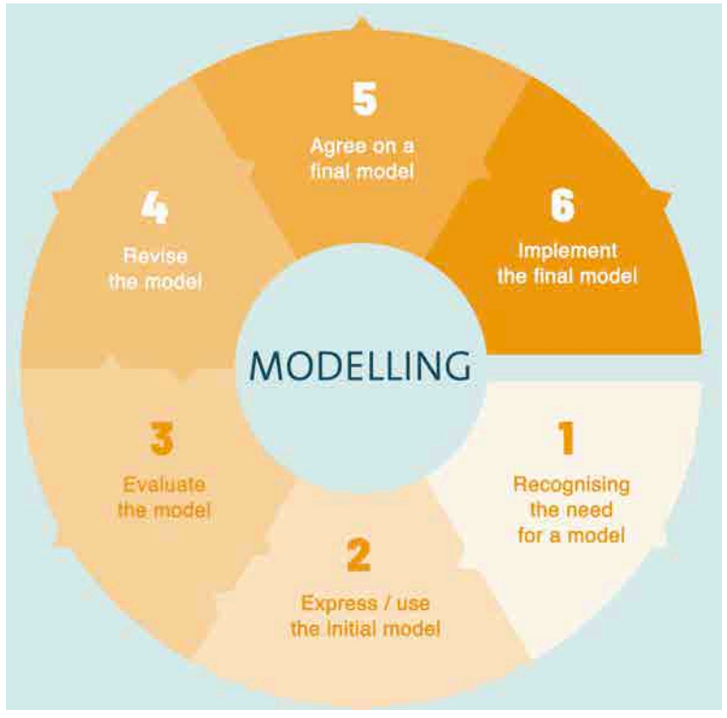
- Form groups of 3-4 students.
- Heterogeneous groups.
- Set a clear goal, but one that cannot be achieved by a single student alone.
- Supervise the work of each group to ensure that individual responsibility is not diluted.
- Provide models and strategies for acquiring the social skills involved in cooperative behaviour, clearly illustrating which behaviours are cooperative and which are not.
- Prevent the groups from adopting strategies in which each student does what they do best.
- Supervise the social interactions that take place within the group and the dialogue about the scientific contents being worked on, in order to optimise both learnings.



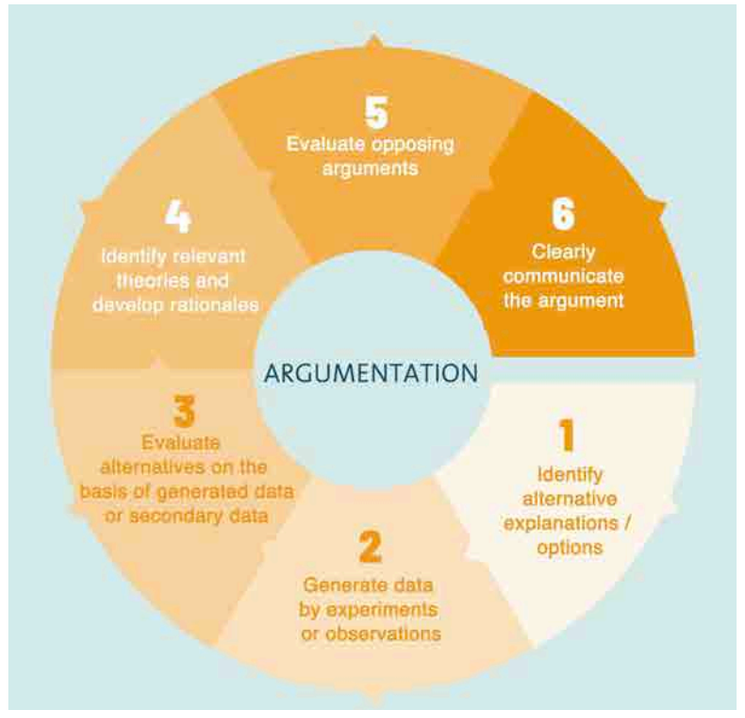
3. Research, modelling and argumentation

The scientific practices most recommended by didactic research are: research, modelling and argumentation.

Research



Modelling

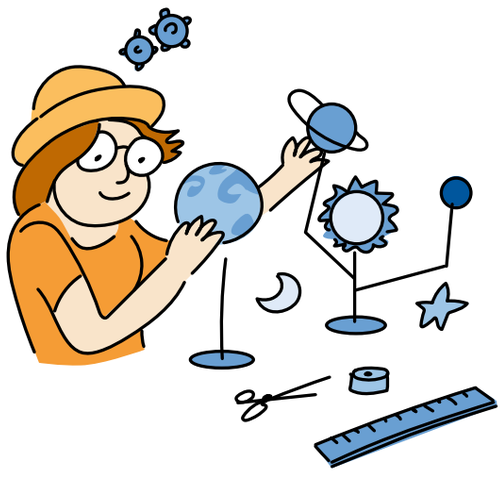


Argumentation

Research, modelling and argumentation

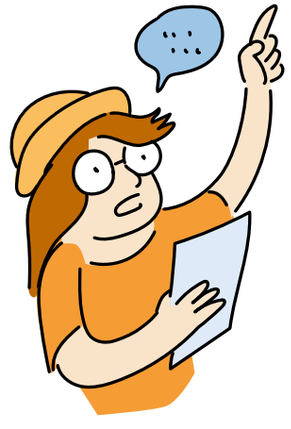
With the guided research teaching model, students learn scientific content, learn to do science (procedures), learn what science is and how it is built. This generates a positive attitude towards science and, above all, it helps the students to develop critical thinking, i.e. To question any statement that is not supported by evidence.

Research, **modelling** and argumentation



Modelling processes allow us to "devise" interpretive models that serve to describe, predict, explain and intervene in phenomena in accordance with what we know and the available evidence and that can be transferred to other contexts.

Research, modelling and **argumentation**



Argumentation is the assessment of knowledge based on evidence. In today's world, in which there is a whole host of unproven pseudoscientific claims and hoaxes, argumentation is a tool for developing critical thinking.

4. Teaching science to form free citizens

• STEAM education, based on dialogue, reflection and critical thinking, allows for the processes of democratisation of scientific and technological knowledge to be practised in the classroom.

• Selecting correct, unbiased information in an environment in which we are constantly bombarded with fake news and "truths" from pseudoscientific gurus, is key to teaching science in the post-truth era. This aspect is particularly important as regards one of the key skills for our present and future science: communication, understanding science as a universal right that should be available to all; to be part of all of us.

• Teamwork in a STEAM environment, based on an interdisciplinary approach, provides a unique opportunity for developing:

- multiple approaches,
- a global awareness of science,
- a fertile ground for fostering a creative approach to identifying and solving complex problems,
- a fundamental tool for the social construction of our future.

Science is, without a doubt, a common good that protects us, drives us and humanises us.

5. Teaching science without gender stereotypes

Research should include:

Girls. At a very young age (around 6 years) they already think that they are less intelligent than their male classmates.

There are two types of stereotypes: explicit and implicit. The latter are deeper, unconscious, and have a powerful influence on our behaviour. These are the stereotypes that perpetuate, for example, the belief that science is a male activity.

Female role models can help girls take an interest in STEM disciplines.

Girls do not seem to perform as well as boys in highly competitive environments.

Myths about teaching science, from a gender perspective:

- ✗ Science (and science education) is unbiased, as it is a completely objective discipline.
- ✗ There is no need to focus girls' education on STEM disciplines. They don't choose them because they don't like them.
- ✗ Teachers at all levels of education are unbiased when assessing the abilities of their students.
- ✗ These gender stereotypes cannot be remedied.
- ✗ The abilities of girls and boys are innately different.
- ✗ Countries that are more advanced in terms of gender equality have more women interested in STEM disciplines.
- ✗ Women who pursue STEM careers advance in the same way as men.
- ✗ Environmental problems and natural disasters affect men and women equally.
- ✗ There is no gender bias in environmental and civic education in schools.

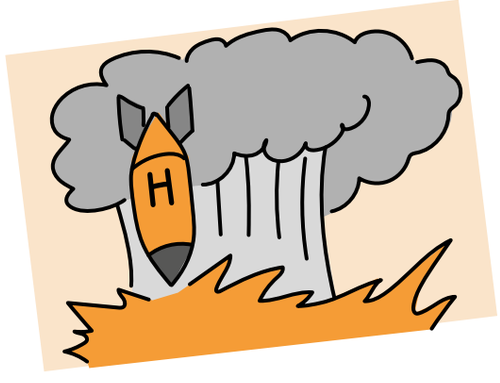
6. Discussing controversial issues in the classroom

Discussing controversial socio-scientific issues in the classroom provides a teaching opportunity for:

- relating scientific ideas to the world of the students

- ensuring that the science we teach is useful

- not only understanding and decision-making, but also for acting as free, autonomous citizens.



Controversial socio-scientific issues are open-ended issues whereby the students make a decision that involves both scientific and social aspects, such as the management of environmental, bioethical or techno-ethical problems.

Whether or not to use nuclear energy, whether to make vaccination compulsory or whether to allow homeopathic products to be sold in pharmacies are issues that we should all be able to take a position on.

These dilemmas are not only associated with science, but also to ethical considerations and personal and social values.

7. “Neuromyths” in teaching and at work

Some of the most widespread myths about the brain in society:

✗ We **only use 10%** of our brain.

✗ Adapting our **teaching methods** to students' learning styles facilitates their learning.

✓ What helps determine how to teach is the type of content or skill we want to teach, not the “learning style” of each student.

✗ There are **left-brain** learners and **right-brain** learners.

✓ **There is no evidence** that the differences between people in terms of creativity, logic or ability to emote are linked to different processing in the right and left hemispheres of the brain.

✗ **Listening to classical music,** especially Mozart, increases students' intelligence.

✗ Young people who have been born and raised surrounded by technology are "**digital natives**".

✗ **Exceptionally stimulus-rich environments** improve children's brains.

FALSE

TRUE

Schools in the Basque Country

What are the elements of effective low and middle socioeconomic level schools?

SCHOOLS

- Positive environment No major problems, working at ease
- Vision: clear, participatory, respected
- Clear leadership: management team
- Effective management, coordination
- Culture of assessment: projects
- High expectations for students and teachers
- Harassment is dealt with
- The staff is united
- The staff is stable
- It is attentive to diversity

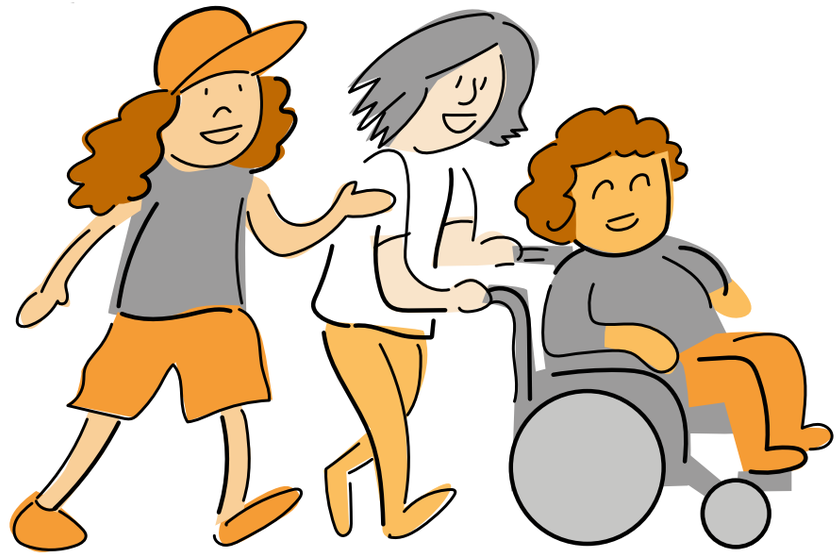
Source: *Irakas-sistema ebaluatu eta ikertzeko erakundea (ISEI-IVEI)*

Schools in the Basque Country

What are the elements of effective low and middle socioeconomic level schools?

STUDENTS

- Direct follow-up through tutoring
- Direct involvement of families
- Effective attention to student diversity
- Attention to students with special needs
- Plurality of methodologies: effective use of books and ICTs
- A rooted culture of assessment



Schools in the Basque Country

What are the elements of effective low and middle socioeconomic level schools?

TEACHERS

- Dedicated and involved
- Motivated for training and continuous improvement
- Work on quality projects
- Well looked after
- Highly engaged

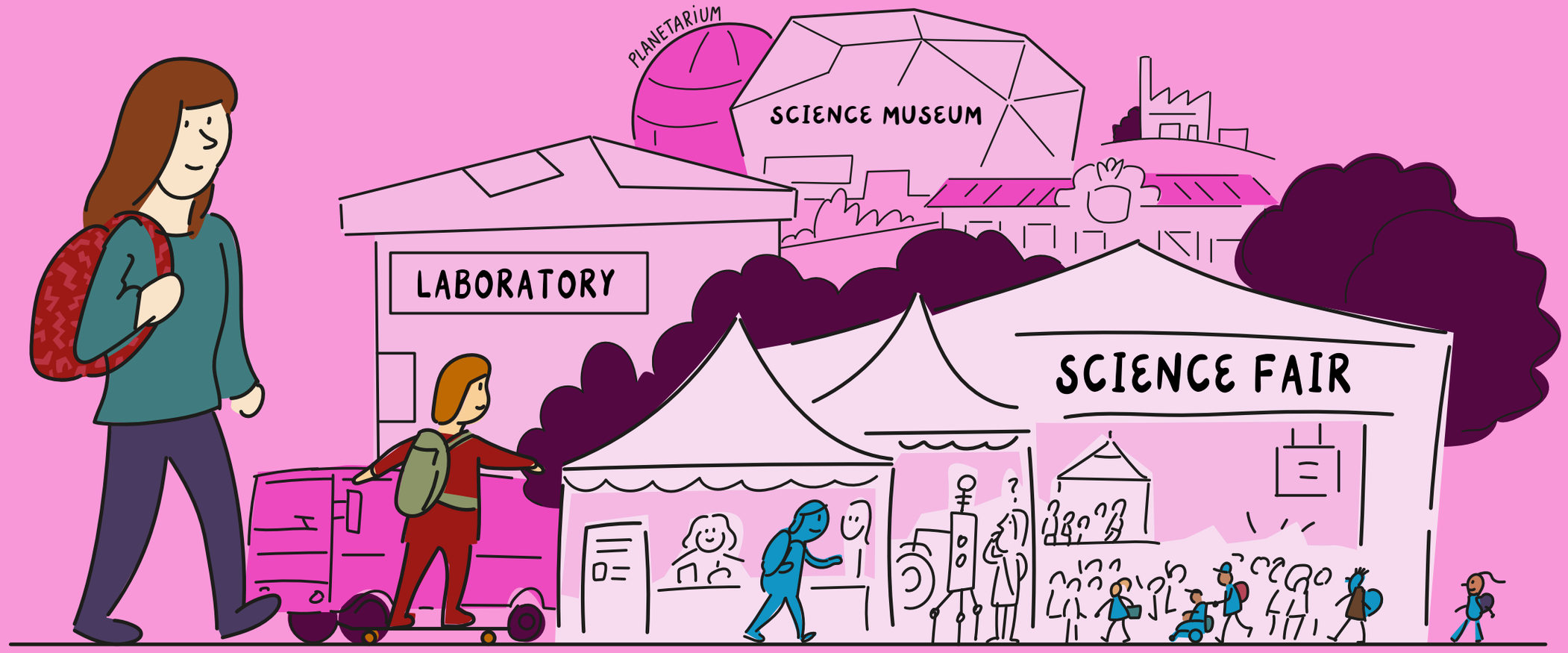
STEAMGUNEA

steamgunea

STEAMGUNEA offers **information, resources and templates to help schools create their STEAM plans.**

This tool was created in 2019 **by the Department of Education of the Basque Government.**

STEAM EDUCATION
BEYOND SCHOOL



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STEAM EDUCATION BEYOND SCHOOL

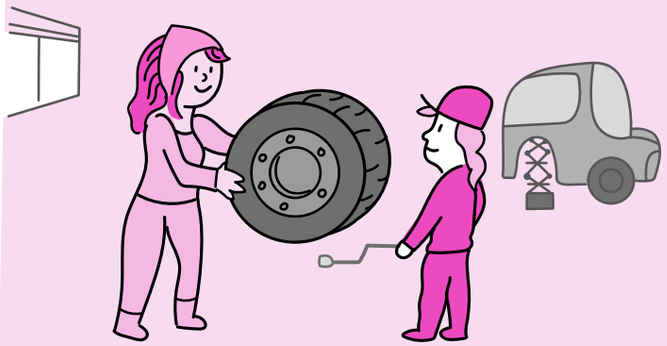
- Fairs, museums, visits, etc.
- Family and peers
- Scientific capital
- STEM role models

STEAM education beyond school

Fairs, museums, visits, etc.

Out-of-school **STEAM** experiences **improve** science literacy

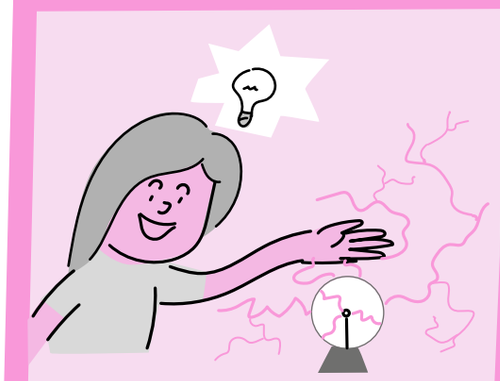
Field trips



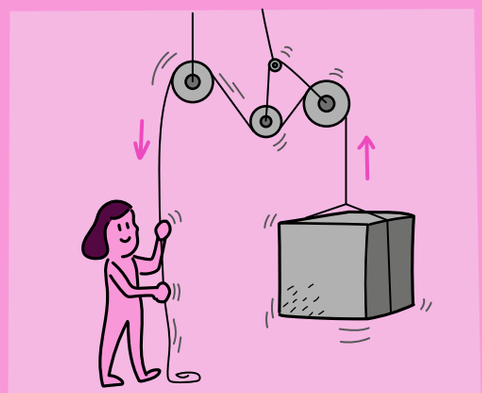
Family activities

Attendance at science fairs, visits to museums, etc.

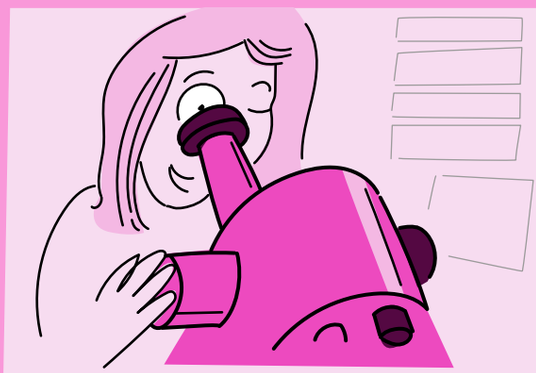
Studies show that these activities have the following **benefits**:



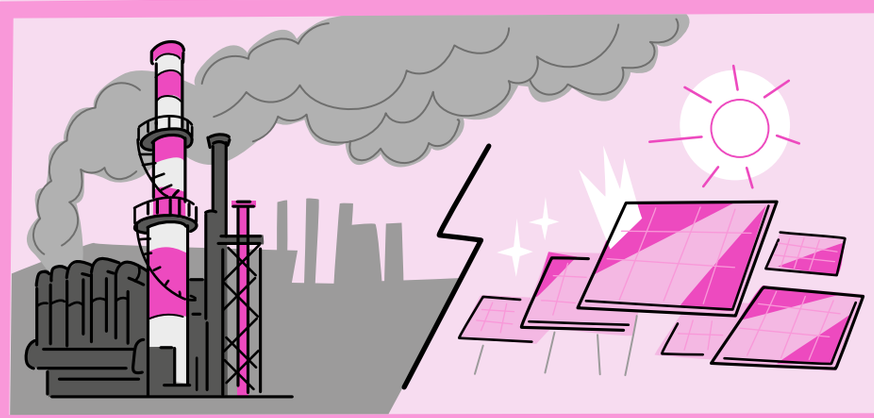
A better understanding of science concepts.



Promote **experiential** learning.



Access to up-to-date materials and **tools**



Allow work on the most critical and social aspects.

Fuente:
"Enseñando ciencia con ciencia"

Allow work on the **more transversal values** of scientific knowledge:

Mae Jemison
American engineer, doctor and astronaut.

- **To correct** incorrect stereotypes.
- To increase the perception of effectiveness, especially **in girls.**

Family and peers

• **Parents, with their beliefs and expectations**, play an important role in shaping girls' interest and their attitudes towards STEM-related studies. **Parents with traditional beliefs about gender roles**, and who treat girls and boys unequally, **can reinforce negative stereotypes**about gender and ability in STEM.

• **The expectations of parents (especially mothers) influence** the educational and career choices of girls more than boys.

• **Higher socio-economic status and parental educational qualifications** are associated with higher scores in mathematics and science (girls and boys). Mothers with higher educational qualifications positively influence girls' achievement in science. Other family members can also influence girls towards STEM.

• **Girls' participation in STEM is also influenced by the socio-cultural context of the family:** ethnicity, language, immigration status, and family structure.

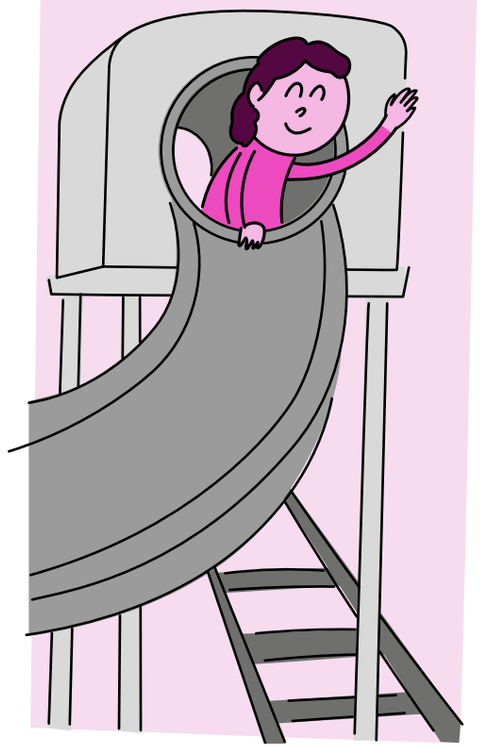
• **Girls' motivation for STEM education is also influenced by their peers;** especially female peers.

Source: *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM); UNESCO, 2019.*

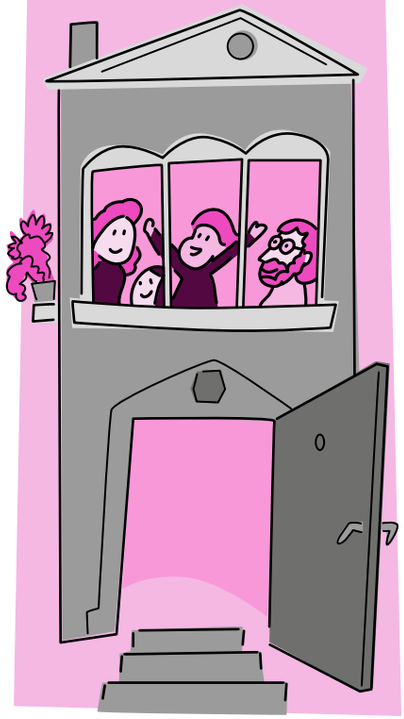
Family and peers

Suggestions for opening STEM up to girls and boys

Lay the foundation for early learning and interest



Involve parents, caregivers and family



Counteract preconceived ideas

Promote dialogue between parents and children

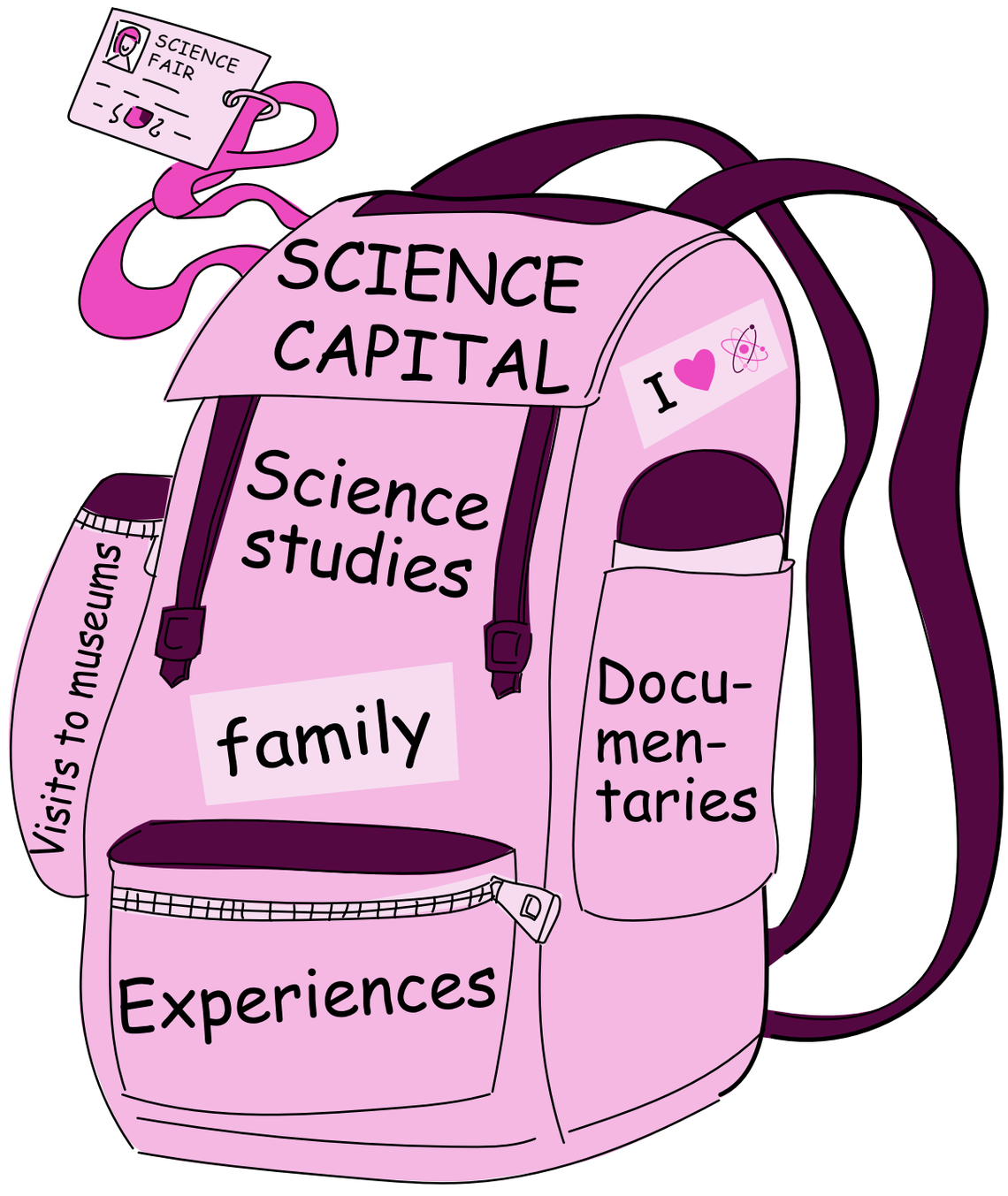
Parents can actively support their children's preparation and motivation to pursue STEM disciplines.

Science capital

Science capital refers to people's level of commitment to science and their relationship with it: how much they value science, to what extent they see the **connection between science and their lives**, to what extent they feel that science is 'for them', and how ‘safe’ they feel with science topics.

- All citizens need **scientific skills**.

- We need to **overcome** *this "I’m more arts”* and *"I’m more science”* divide.



Science capital

- **Science capital of families:** Young people from families with high science capital are more likely to pursue STEM careers than young people with low science capital.

This situation prevents breaking with the homogeneity of the type of professionals in STEM.

- **Low science capital means that they are not aware of the many different STEM occupations..**

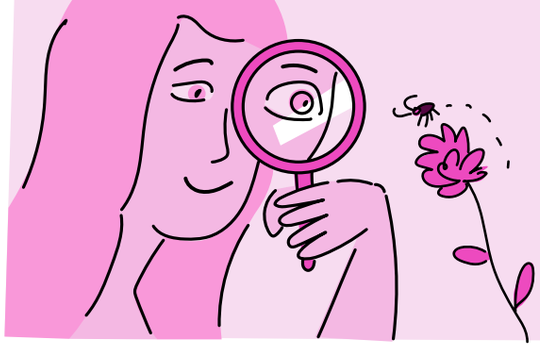
Most young people are only aware of the most common STEM occupations: scientists, engineers, teachers, etc. As a result, **they think (mistakenly)** ***“STEM is not for me”*****.**

How to increase people's science capital

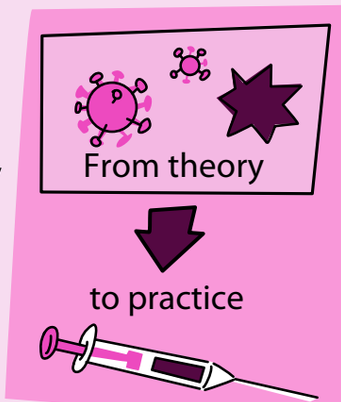
Eight aspects for **increasing science capital:**

1 **Science literacy**

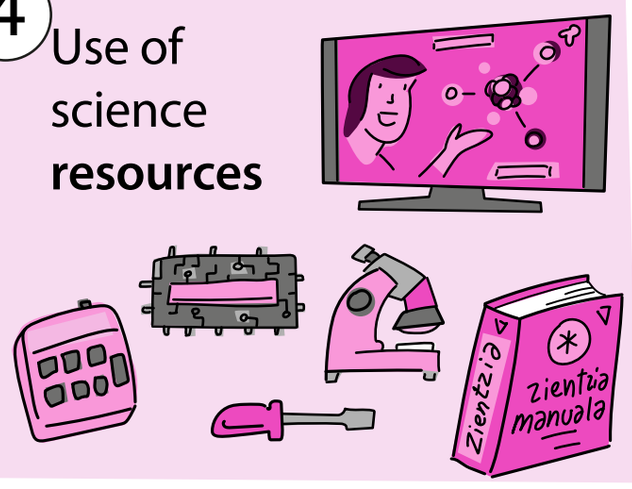
2 **Attitudes,** values and trends in science



3 Knowledge about the **transferability** of science



4 Use of science **resources**



5 **Participating** in extracurricular **activities** to learn science

6 Skills, knowledge and qualifications of **the family**

7 **Meeting people** who work in **science**

8 **Talking about science** in everyday life

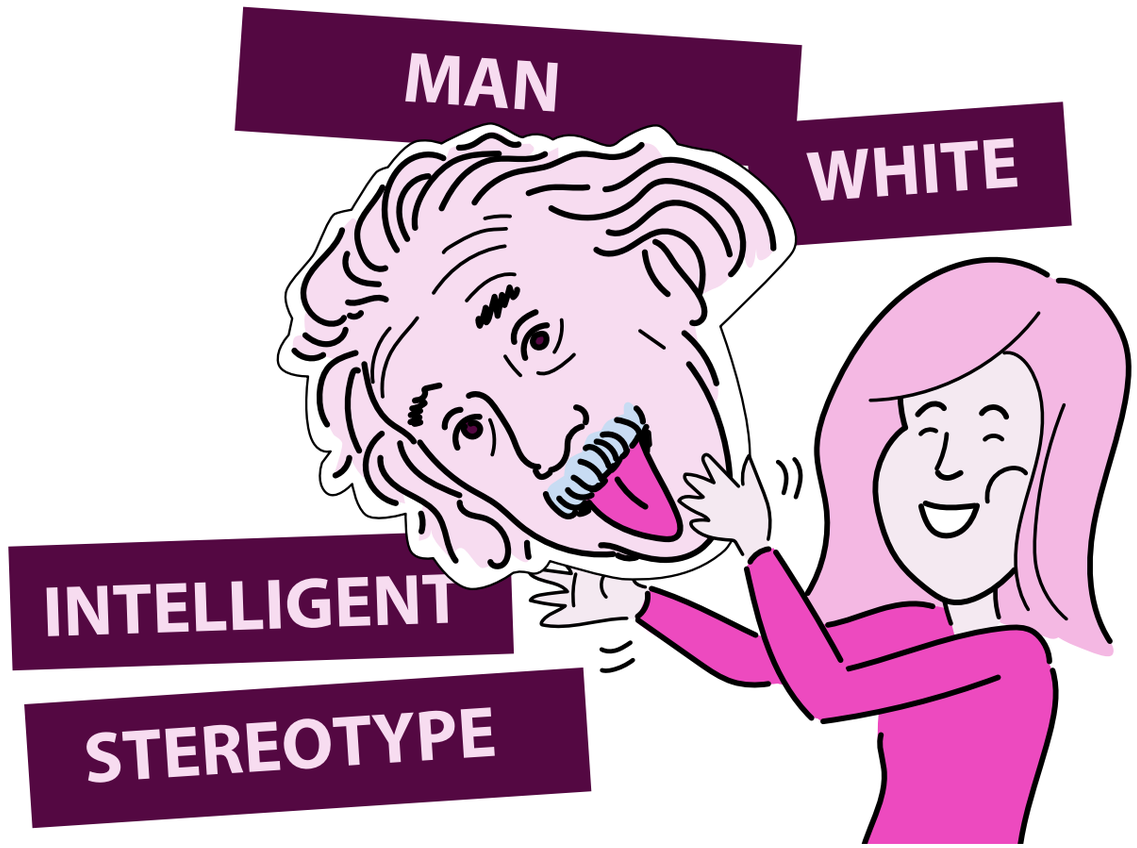
Each of these aspects can help us to design and offer **better activities for STEAM education**

STEM role models

- **The stereotypical image of STEM professionals and STEM studies discourages many young people.**
- Young people believe that STEM professionals are: "very smart", "nerds" and "freaks/geeks"; and therefore think *"I'm not like that and this is not for me"*.
- Equality issues, and especially gender issues, are also **evident at a young age**.
- **Girls choose STEM studies** less often than boys, but a higher percentage of **girls like science from an early age.**

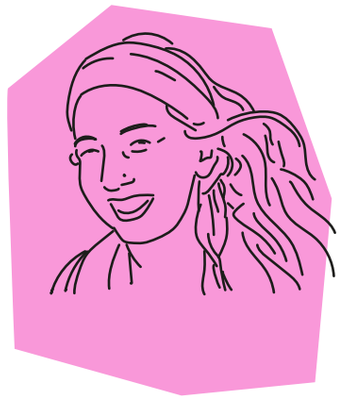
It is unlikely that anyone who is not considered the "smartest" in school will want to study science.

Students are more likely to show a preference for science if they are male and white, and if they have high or very high cultural capital, because they feel identified with this image.



STEM role models

• It is unusual for “feminine” (or very feminine) women to opt for STEM studies.



• **Female role models can encourage** girls to pursue careers in STEM disciplines.

• **Female teachers seem to be more effective** at encouraging girls to pursue STEM careers.

It is recommended, especially with **girls, to carry out extracurricular STEM activities,** or activities involving role models, such as meetings with them, videos or presentations of success cases.

Read our stories:
https://aldizkaria.elhuyar.eus/ekinean/

STEM PROFESSIONS: UNIVERSE OF GALAXIES

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STEM OCCUPATIONS: UNIVERSE OF GALAXIES

- Most valued skills in the world of work.
- STEM professions... Only these?
- From study to the galaxy of professions.
- OrientaTU.
- Professions and studies in the STEAM Euskadi strategy.
- The Amazingly Enormous STEM Careers Poster.

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The most valued skills in the world of work

2015

1. Conflict resolution
2. Collaborative work
3. Group management
4. Critical thinking
5. Negotiation
6. Quality control
7. Guidance service
8. Judging and decision-making
9. Active listening
10. Creativity

2020

1. Conflict resolution
2. Critical thinking
3. Creativity
4. Managing groups
5. Collaborative work
6. Emotional intelligence
7. Judging and decision-making
8. Guidance service
9. Negotiation
10. Cognitive flexibility

Fuente: *Future of jobs report, World economic Forum*

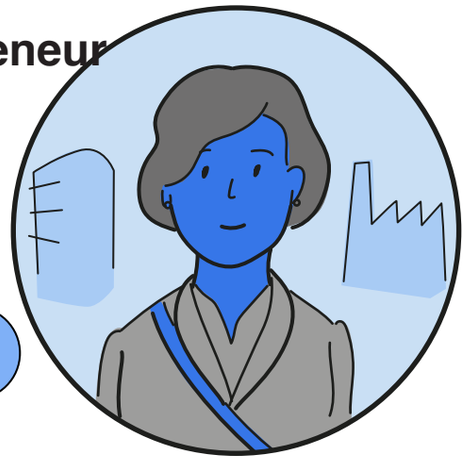
STEM professions ... Only these?

Communicator

Researcher

Programmer

Entrepreneur



Regulator

Explorer

Supplier

Professional

Teacher

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From studies to the galaxy of professions

Sciences

Engineering

Health Sciences

Architecture

SCIENCES

Source: Universidad de Granada

Biology

Food microbiology analyst • Scientific animator • Environmental auditor • Biostatistician • Bioinformatician • Health biologist • Nutrigenomics counsellor • Genetic counsellor • Breeder of insects for natural control • Algae farmer • Environmental communicator • Biofuel specialist • Environmental and chemical safety specialist • Gene therapy expert • Aquaculture farm manager • Technology transfer manager • Farm school monitor • Neurobiologist • Oceanographer • Environmental journalist • Quality manager • Stem cell technician • Air pollution control technician • Integrated agricultural and ecological production systems technician • Agricultural soil restoration technician • Food safety management technician • Research support technician • Gene therapy technician • Waste treatment technician• Technician in environmental management systems • Integrated pest control management technician • Technical specialist in planning, management and organisation of natural areas • Health visitor

Biochemistry

Environmental auditor • Water analyst • Biochemist • Biomaterials specialist/ researcher • Pharmaceutical marketing specialist • Gene therapy expert • Clinical trials monitor • Laboratory technician • Clinical analysis technician • Food industry technician • Pharmaceutical industry technician • Quality control technician • Biotechnology marketing manager • Environmental technician • Waste treatment technician • Technology platform manager • Pharmaceutical product manager • Stem cell technician • Research and development technician • Pharmaceutical development technician • Crystallography, nanotechnology, proteomics or sequencing technician/specialist • Health visitor

Biotechnology

Novel foods research specialist • Clinical trial monitor • Neurobiologist • Regulatory affairs manager • Biotechnology communications manager • Pharmacoeconomics manager • Biotechnology marketing manager • Bioinformatician • Nutrigenomics counsellor • E-Health consultant • Biofuels specialist • Systems biology specialist • Catalytic processes and catalysis specialist • Gene therapy expert • Biomaterials researcher • Industrial property manager specialised in biotechnology • Technology transfer manager • Technology surveillance manager • Analytical technician • In-vitro assay technician • In-vivo assay technician • Stem cell technician • Technical specialist in crystallography • Technical specialist in nanotechnology • Technical specialist in proteomics • Technical specialist in Sequencing

Environmental sciences

Environmental auditor • Acoustic consultant • Algae farmer • Environmental reporter • Environmental educator • Biofuels specialist • Geographical information systems specialist • Environmental manager • Aquaculture farm manager • Environmental interpreter-guide • Environmental journalist • Secondary school, university or vocational training teacher • Technical specialist in sewage and wastewater treatment • Water control technician • Technical specialist in environmental restoration • Technical specialist in treatment and recycling of MSW • Technical specialist in integrated analysis and control of river pollution • Technical specialist in control of air pollution in industrial installations • Technical specialist in sustainable management of natural spaces • Technical specialist in planning and development of natural spaces • Technical specialist in energy efficiency in construction • Environmental technician

Food science and technology

Quality control laboratory technician • Food quality control technician • Food industry technician • Food microbiology analyst • Food counsellor • Nutrigenomics counsellor • Sensory analysis specialist • Food establishment evaluator • Food establishment expert • Food packaging applications expert • Fair trade expert • Expert in integrated quality management, environment, occupational risk • Food legislation expert • International food sales manager • Wholesale food sales manager • Customer and consumer communications manager • Novel foods research specialist • Industrial catering supervisor • Food additives and flavourings sales technician • Food safety technician • Technical specialist in nutritional information

Statistics

Digital analyst • Analyst of economic and management studies • IT technical advisor • Biostatistician • Data scientist • Chief data officer • Lecturer • Big Data specialist • Medical statistician • Expert in customer satisfaction measurement • Statistician in data centres and sociological companies and consultancy firms • Planning technician in service companies or any kind of company • Market research technician • Data processing technician • Prospecting specialist

Physics

Systems analyst or programmer • Cloud architect • Environmental auditor • Acoustics consultant • Data scientist • Software developer • Laboratory manager • Production manager • Lecturer • Big Data specialist • Systems biology specialist • Cyber security specialist • Cloud specialist • Medical physicist • Biomaterials researcher • Meteorologist • Drone pilot • Applications programmer • Energy and alternative energy technician • Quality technician • R&D technician • Specialist in developing data transmission equipment and networks • Specialist in developing telephony and telecommunications equipment • Environmental technician (control of air and noise pollution, management systems) • IT technician • With MBA training: sales, company director or advisory consultant

Mathematics

Data analyst • Analysts • Programmers • Risk analyst • Digital archaeologist • Big Data architect • Risk Analyst • IT advisor • Technical advisor • Mechanical astronomer • Data scientist • Coders • Mobile application developer • Big Data specialist • Cyber security expert • Computer scientist • Mathematician • Numerical methods • Geodesy technician • Computer science technician • Quality control technician • Cryptography technician • R&D technician • Financial technologist • Communication networks

Geology

Geologist • Marine geologist • Public works geologist • Borehole geologist • Geophysicist • Geochemist • Hydrogeologist • Seismologist • Volcanologist • Mineralogist • Sedimentologist • Palaeontologist • Geological engineer • Construction project analyst • Geological resources analyst • Cartographer • Occupational risk prevention expert • Environmental manager • Environmental auditor • Geographical information systems specialist • Geohistorian

Optics / Optometry

Optician • Optical technician • Technical director at optical establishments • Technical director at optometric centres • Optics and optometry key account specialist • Optometrist in ophthalmology and refractive surgery services (public or private) • Visual screening technician • Specialist in the study, design and manufacturing of optical components • Optical and electronic equipment operator • Medical visitor • Occupational health and safety technician • Photogrammetry technician • Holography technician • Trainer in non-official courses • Educator

Chemistry

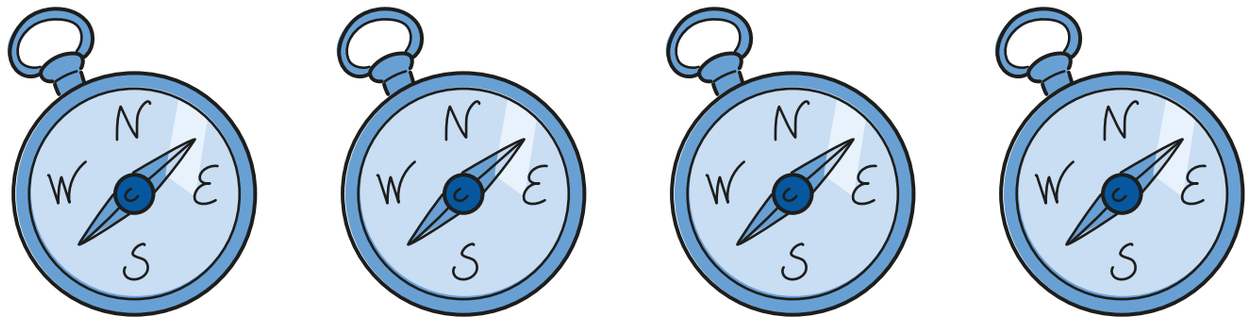
Water analyst • Environmental auditor • Food advisor • Process controller • Product specialist • Biofuels specialist • Geochemist • Biomaterials researcher • Chemist • Quality control technician • Environmental technician • Chemical safety technician • Waste and water treatment technician • Renewable energy technician • R&D+I technician • In-vitro assay technician • Clinical analysis technician • Laboratory technician • Technician in the food and pharmaceutical industries • Health visitor

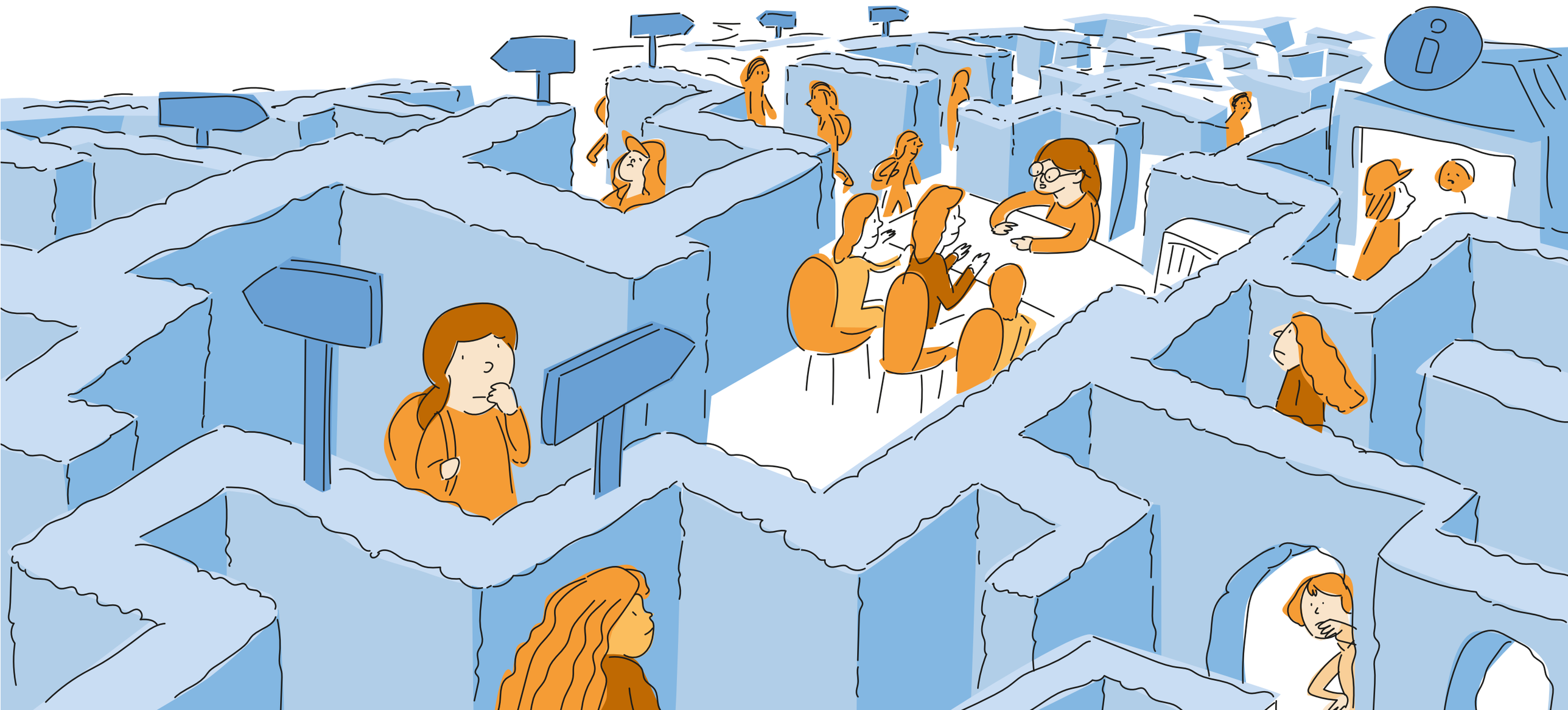
More information:
"Guía Salidas Laborales Universidad de Granada"

OrientaTU

With the Basque Country context in mind, public entities have published several guides and guidance materials on the Internet, some published by the UPV/EHU and others by the Basque Government:

OrientaTU, Aurrera, GPS, Educaweb.





Professions and studies in the STEAM Euskadi strategy

PROFESSIONAL TRAINING: 11 out of 26 professional families linked to STEM occupations

1. Physical activities and sports
2. Administration and management
3. Agriculture
4. Graphic arts
5. Arts and crafts
6. Commerce and marketing
7. **Electricity and electronics ✓✓**
8. **Energy and water ✓✓**
9. **Construction and civil engineering ✓✓**
10. **Mechanical manufacturing ✓✓**
11. Hotels, catering and tourism
12. Extractive industries
13. **Information technology and communications ✓✓**
14. **Installation and maintenance ✓✓**
15. Personal image
16. **Sound and image ✓✓**
17. **Food industry ✓✓**
18. **Wood, furniture and cork ✓✓**
19. Maritime and fishing
20. **Chemicals ✓✓**
21. Healthcare *
22. Safety and environment *
23. Socio-cultural and community services
24. Textiles, clothing and leather
25. **Transport and vehicle maintenance ✓✓**
26. Glass and ceramics

UNIVERSITY: 2 out of 5 fields of study linked to STEM occupations

1. **Engineering and Architecture ✓✓**
2. **Sciences ✓✓**
3. Health Sciences*
4. Social Sciences* and Law
5. Arts

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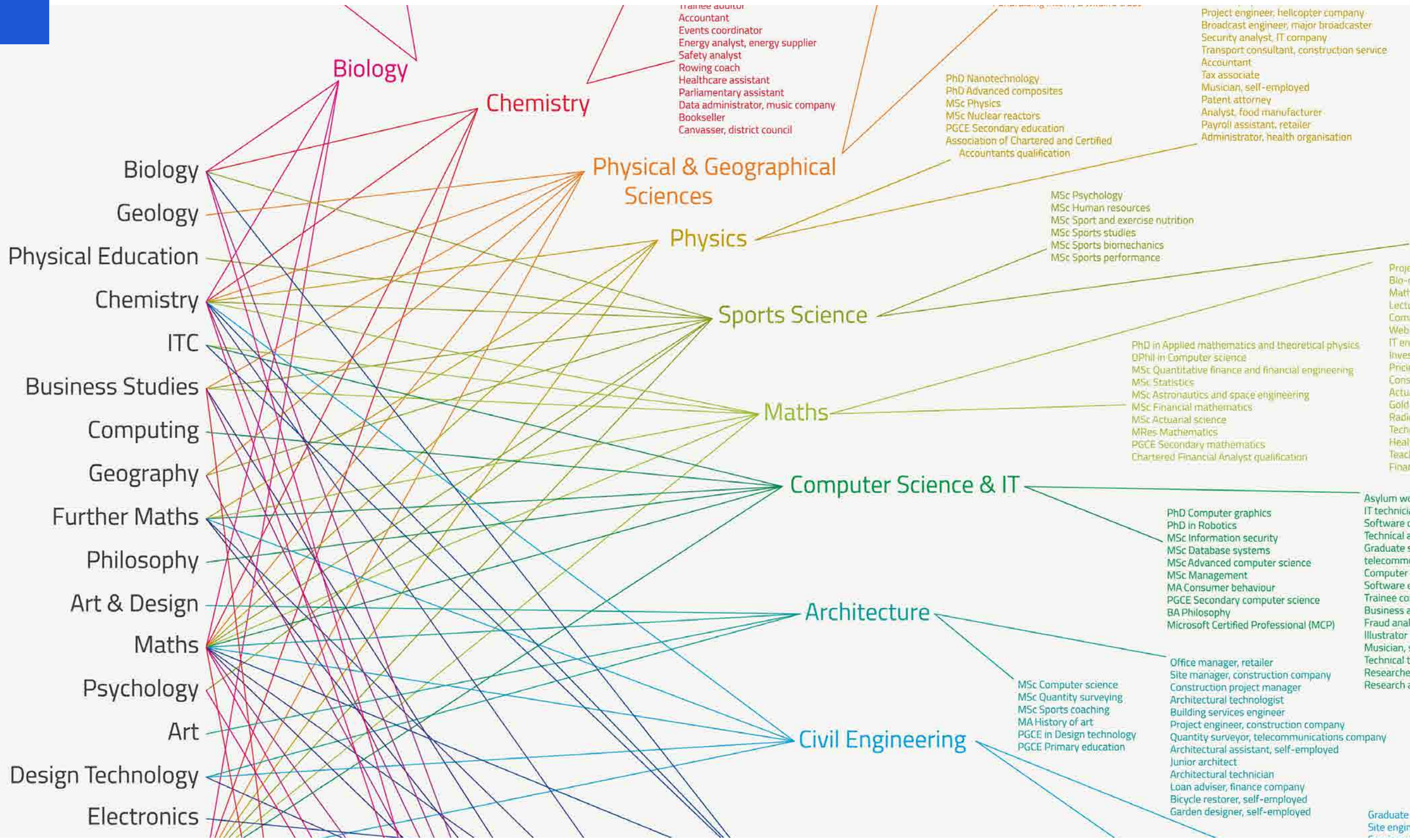
The Amazingly Enormous STEM Careers Poster

Based on the education system and needs of UK society



Source: https://findingada.com/wp-content/uploads/2015/10/Ada-Lovelace-Day-STEM-Careers-Poster.jpg

STEAM, GIRLS AND WOMEN

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STEAM, GIRLS AND WOMEN

- The situation of women in STEM studies

- Factors influencing participation of women.

- Promoting women's interest in STEM

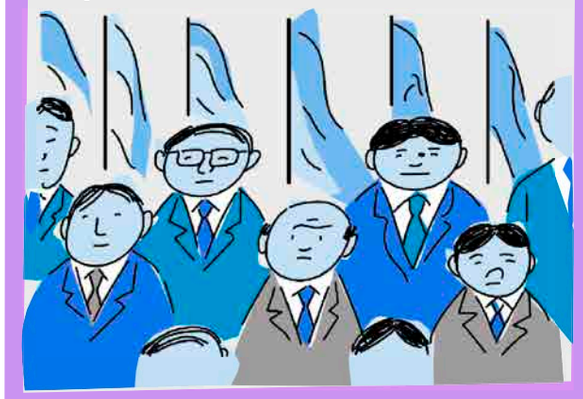
Situation of women and girls in the world

Throughout the **world**

women suffer more inequality and poverty.

Influencing factors:

- Social, cultural and **political** factors



- Income disparity and wage gap.

- Girls have **less access to education.**

- The **double** shift.

Women and girls account for 60 percent of the people who are chronically hungry in the world

Source:
The World's Women 2015.
Trends and Statistics.
UN

Status of women and girls in STEM studies

Girls are left behind

very soon in STEM education,

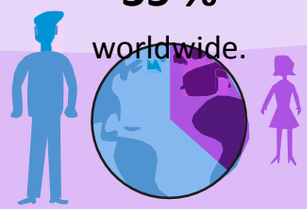
from early childhood, in games related to the theme.

In higher education, these differences go even further.

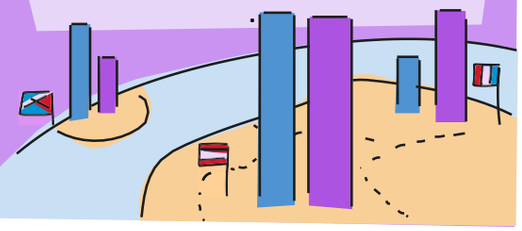
Girls lose interest

more and more between the first and last years of adolescence.

In **higher STEM education, young women** account for only **35 %** worldwide.

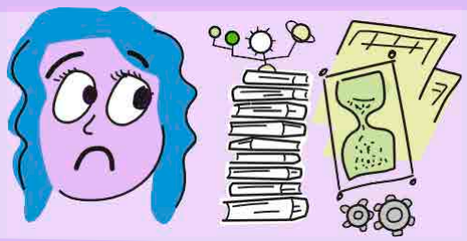


There are important **differences** in female representation in STEM studies **between countries**, suggesting **contextual factors**



The percentage of **abandonment** of STEM disciplines at **university and** at **work** is **much higher in women**.

Women do not pursue STEM professions, despite the time and energy invested in their education.



Reasons:

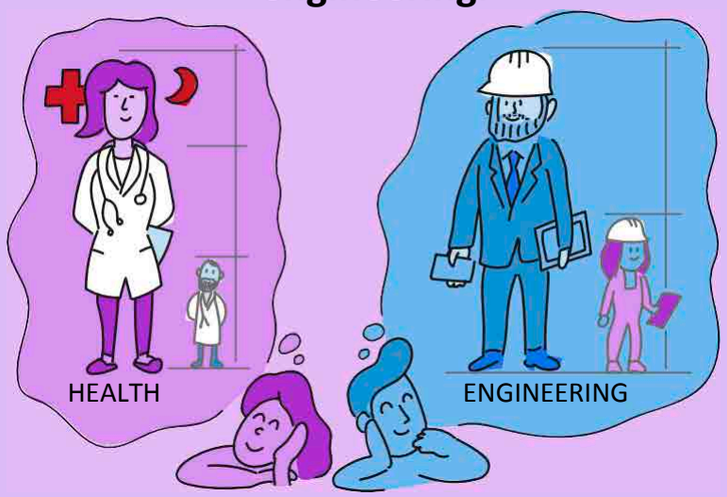
- Perception of **incompatibility** with female identity.

- Social allocation to women in family care.

- Environment and working conditions.

PISA 2015:

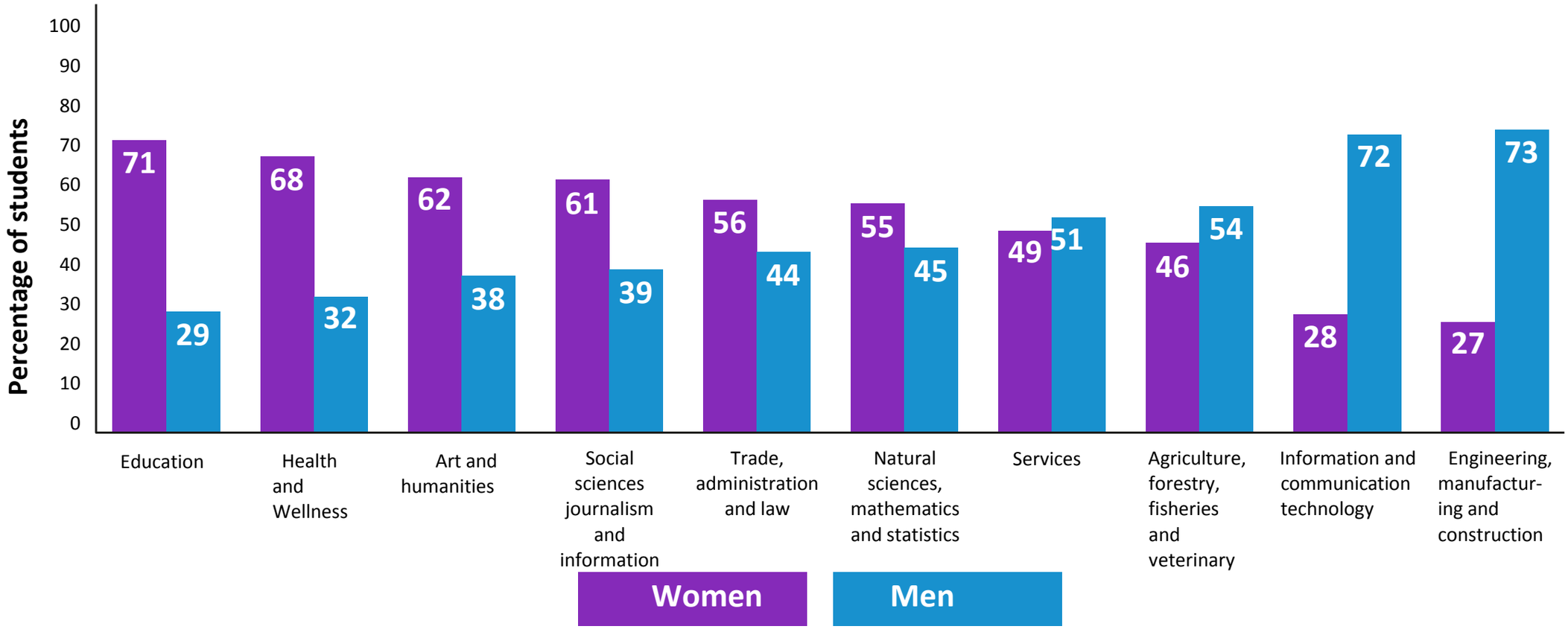
Girls were **three times more likely** than boys to work in **health-related professions**, while **boys doubled** the girls in seeing themselves working in **engineering.**



Source:
"Decipher the code. The education of girls and women in science, technology, engineering and mathematics (STEM)". UNESCO, 2019.

Worldwide data

Significant gender differences in higher education enrolment by area of study.

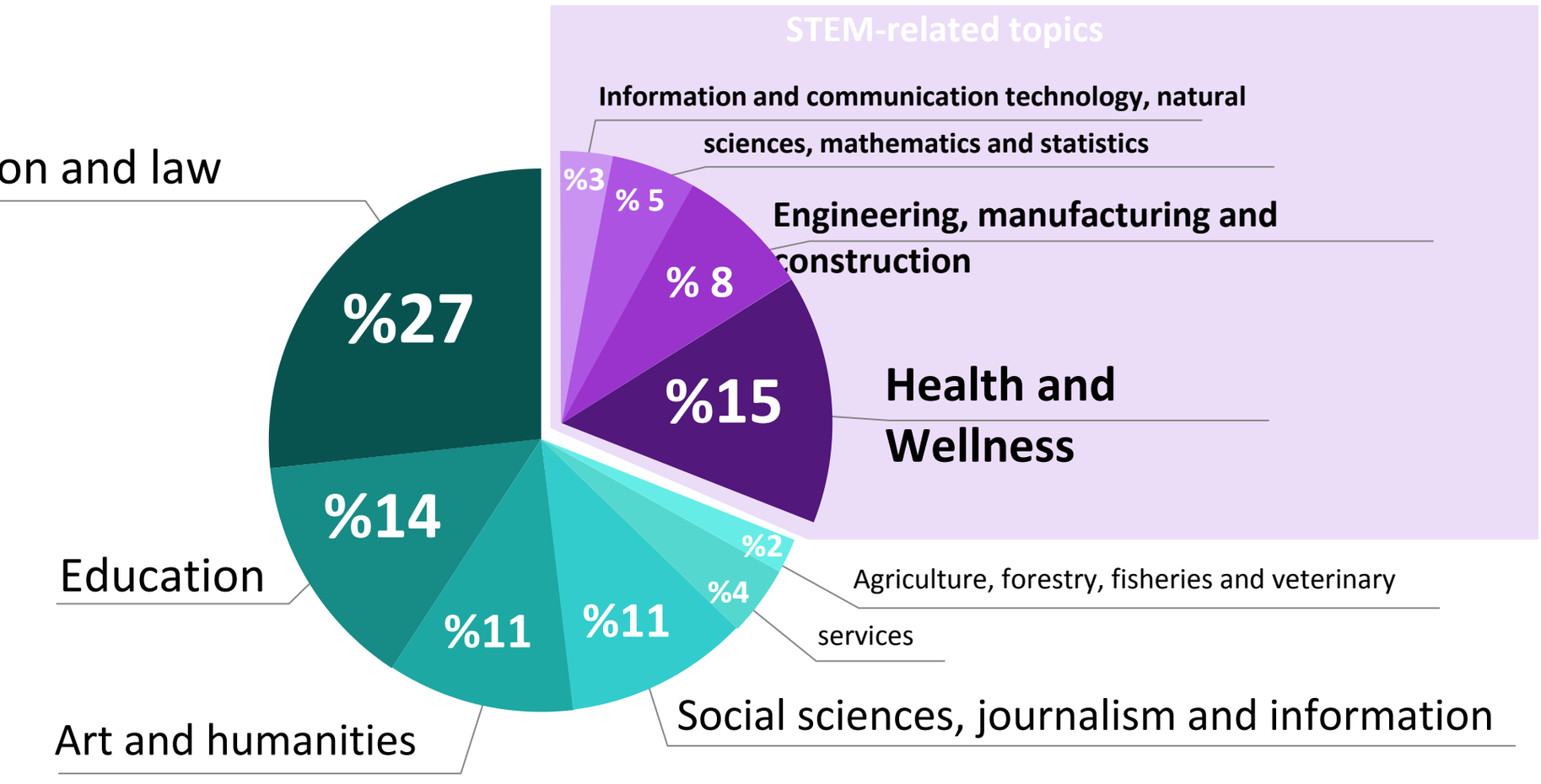


Proportion of female and male students enrolled in tertiary education, by field of study, world average

Source:
"Decipher the code. The education of girls and women in science, technology, engineering and mathematics (STEM)". UNESCO, 2019.

Worldwide data

Only 30% of all students select STEM-related fields in higher education.

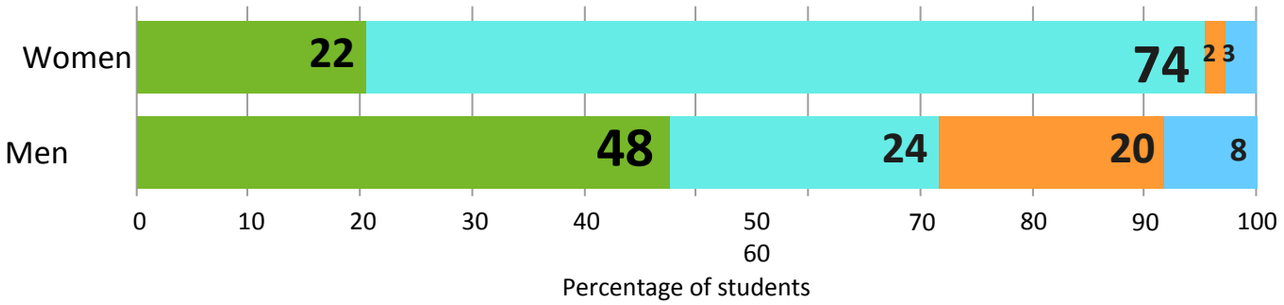


Distribution of female students enrolled in higher education, by field of study, world average

Source:
"Decipher the code. The education of girls and women in science, technology, engineering and mathematics (STEM)". UNESCO, 2019.

Worldwide data

Most 15-year-old girls who intend to pursue scientific careers expect to work as health professionals.



Expectation to work as **science and engineering professionals.**

Expectation to work as **health professionals.**

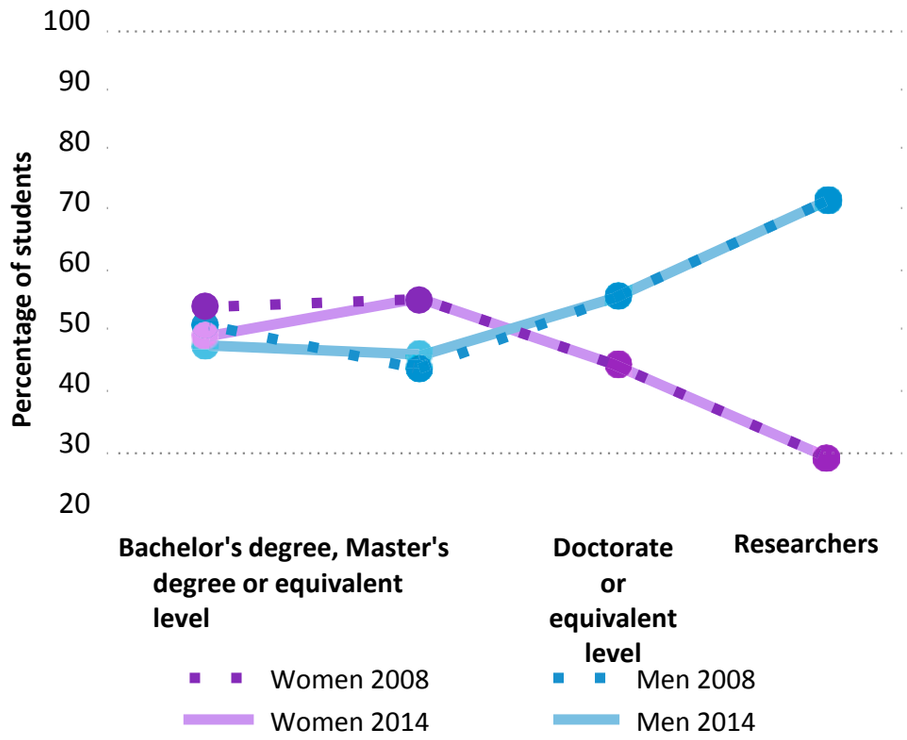
Expectation to work as **ICT professionals.**

Expectation to work as **technicians related to science, or associated professionals.**

Expectations of students in science careers (age 15), world average

Data source: **PISA 2015 (OECD countries)** [17]

The gender gap is widening significantly among scientific researchers.



Proportion of women and men in higher education and research, world average

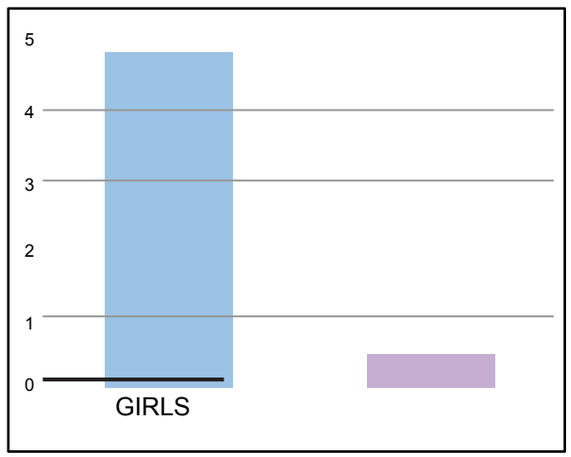
Data source: **UNESCO 2008-2014** [11]

Gender gap in STEM careers:

	Men		Women		Total
	Number		Number		Number
Arts and human sciences	2,328	*38 %*	3,868	*62 %*	6,196
Science	1,958	*48 %*	2,136	*52 %*	4,094
Health sciences	2,062	*24 %*	6,690	*76 %*	8,752
Social and legal sciences	13,561	*42 %*	19,059	*58 %*	32,620
Engineering and architecture	10,958	*73 %*	4,137	*27 %*	15,095
TOTAL	30,867	*46 %*	35,890	*54 %*	66,757

Students enrolled at universities in the Basque Autonomous Community. 2012/2018
*Degrees, Master's and Doctorates

Source: *Eustat.*



According to PISA 2015 results, 4.8% of boys and 0.4% of girls aspire to an ICT career.

PISA 2015

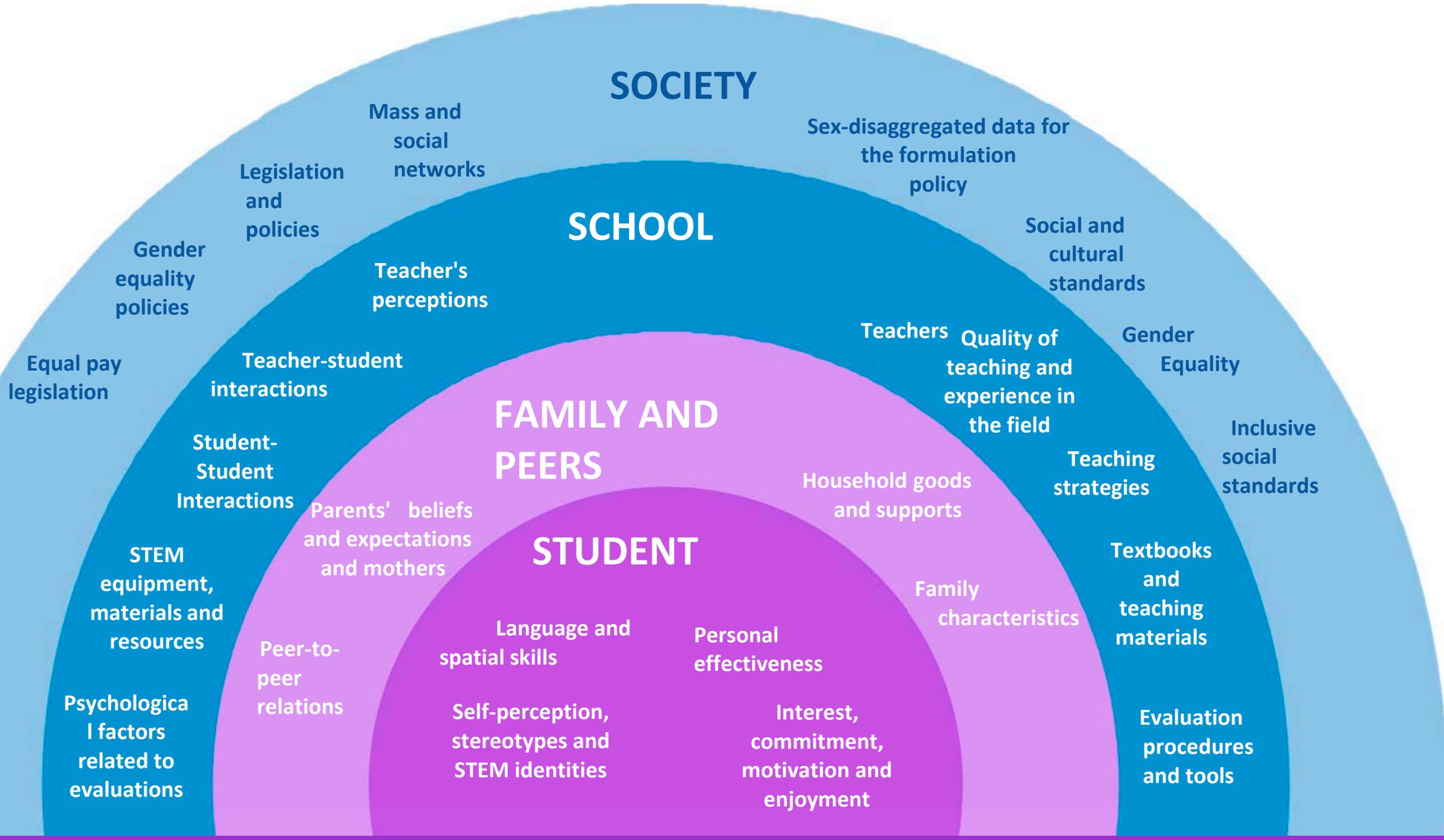
ICT career intention:

4.8% of boys

0.4% of girls

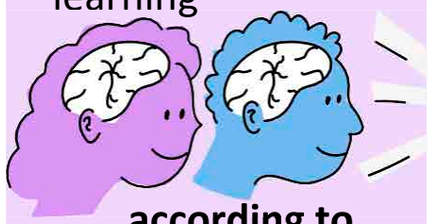
Factors affecting participation of women and girls

Ecological framework of factors influencing female participation, performance and progression in STEM studies



Individual, family and peer factors

No neural **differences** in learning

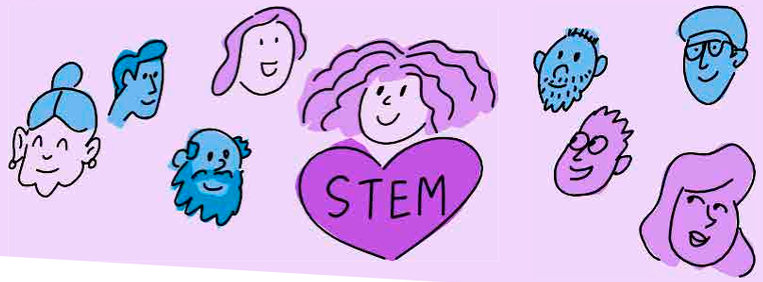


according to sex.

Studies suggest **growing interest** in **STEM in** girls' childhoods.

FAMILY AND PEER FACTORS

The **role** played by the family and its extensions in the attitude of girls towards STEM is also very **important.**



Parents' beliefs and expectations influence their children

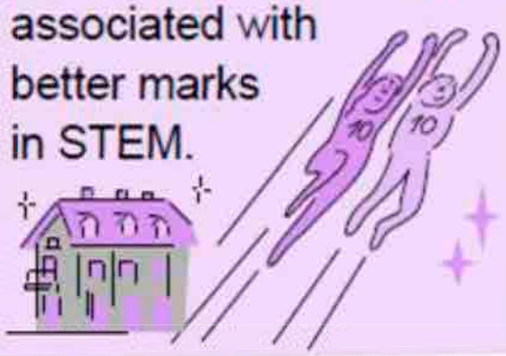
- The **educational** level and **profession of** the parents.

- The degree of **support at** home.

- Parents with **traditional** beliefs that treat girls and boys **unequally** may **reinforce negative stereotypes** about STEM skills.

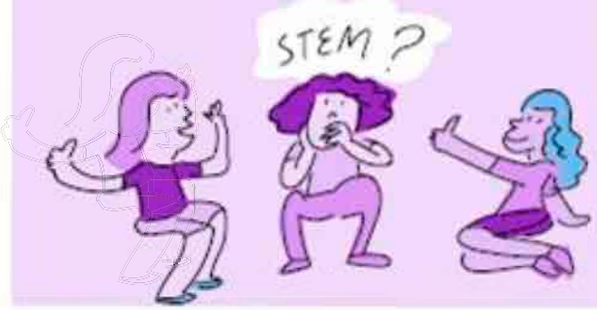
- The expectations of **mothers** have a great influence on the **girls'** career choices.

- The **socio-economic** situation of the family is associated with better marks in STEM.

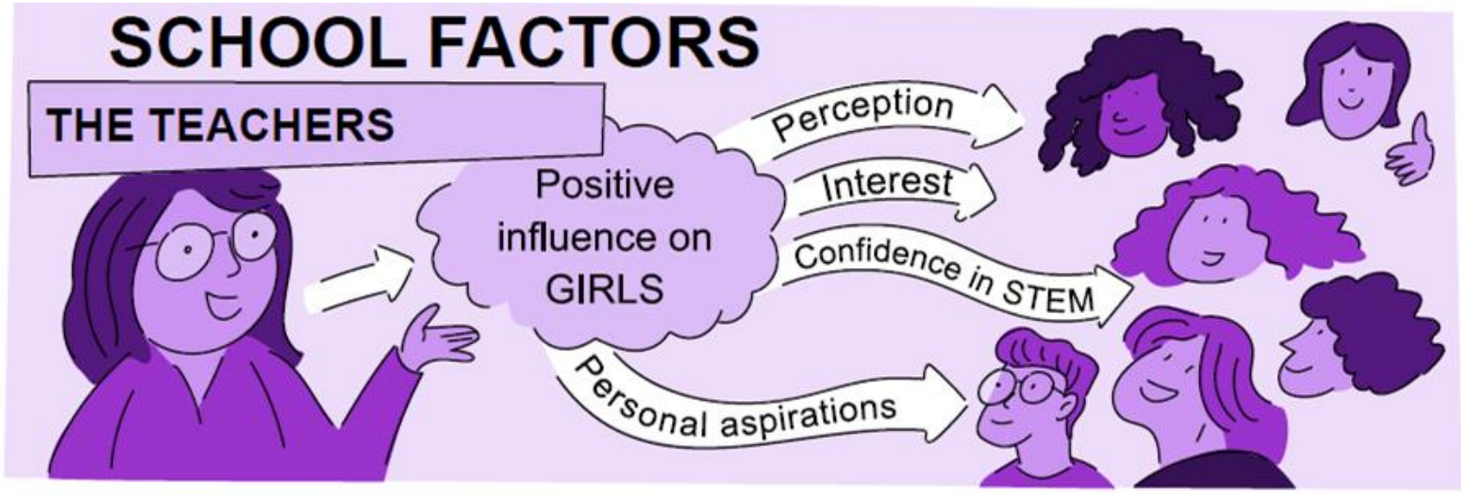


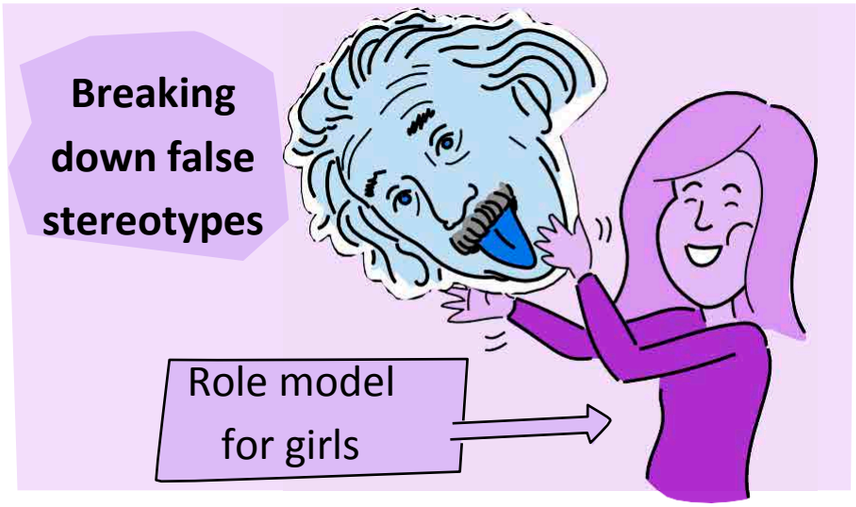
- The **socio-cultural** situation family also influences the future STEM of the children.

- **Peers**, especially **women**, also influence **girls'** interest in STEM.



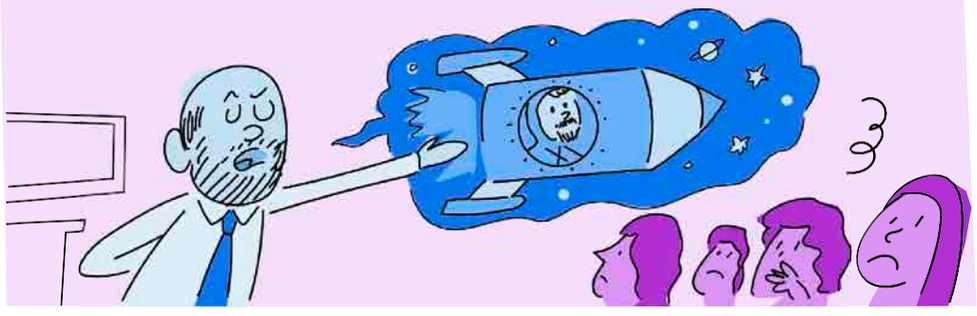
School factors





THE TEACHERS

Teachers' beliefs and **attitudes** have an important effect on **girls** in STEM subjects.

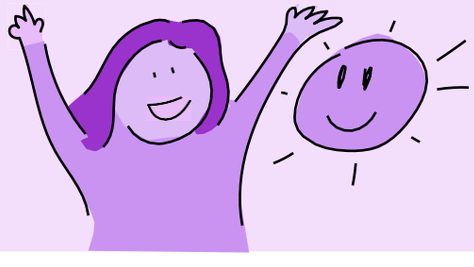


It is critical to pay **attention to gender dynamics** in the classroom and school environment.

Educational plans and materials need to have **positive messages about women** and girls, with interesting themes, questions and **practices**.

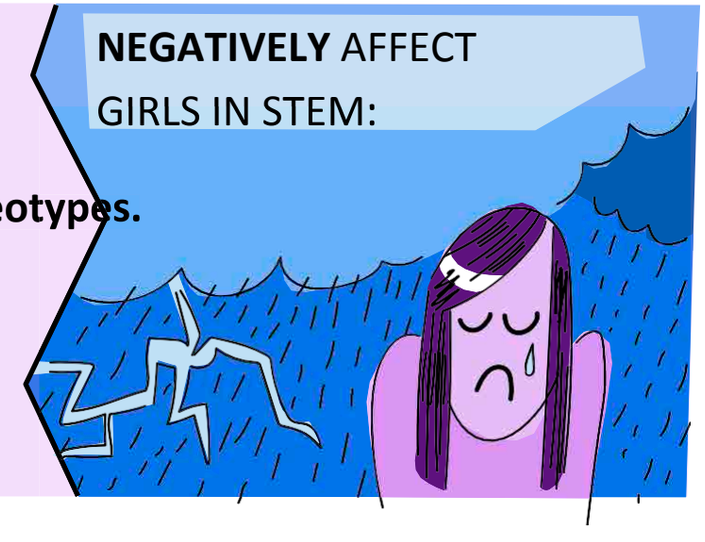
IMPROVING GIRLS' INTEREST IN STEM:

- Experiences
- **Real life** STEM-related



NEGATIVELY AFFECT GIRLS IN STEM:

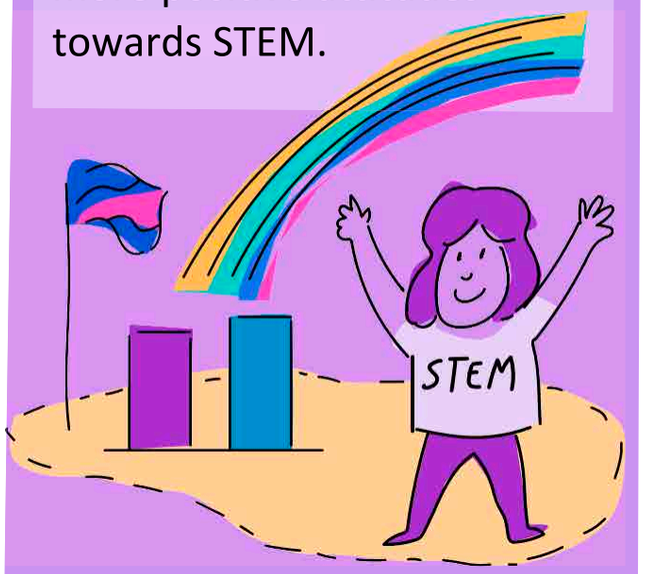
- **Gender bias.**
- **stereotypes.**



Social factors

Cultural and social norms influence the aspirations of **girls**.

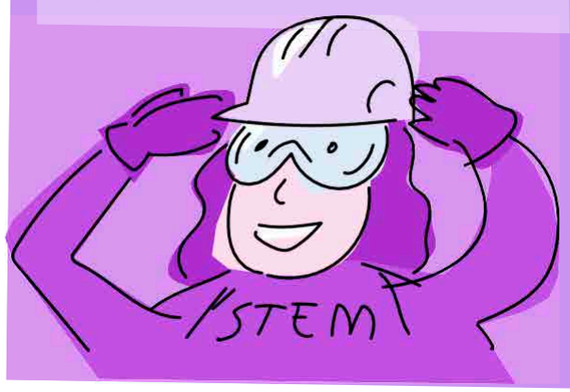
In countries with more **gender equality**, girls have more positive attitudes towards STEM.

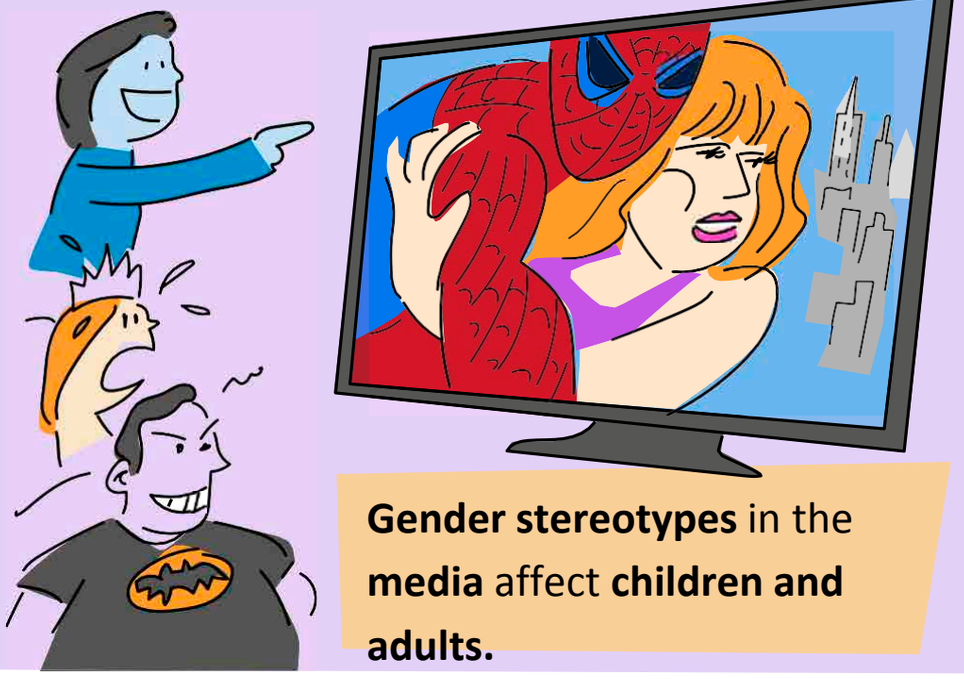


The **measures** to promote **gender equality**:

- Fees
- Incentives
- ...

increase **female participation** in STEM.

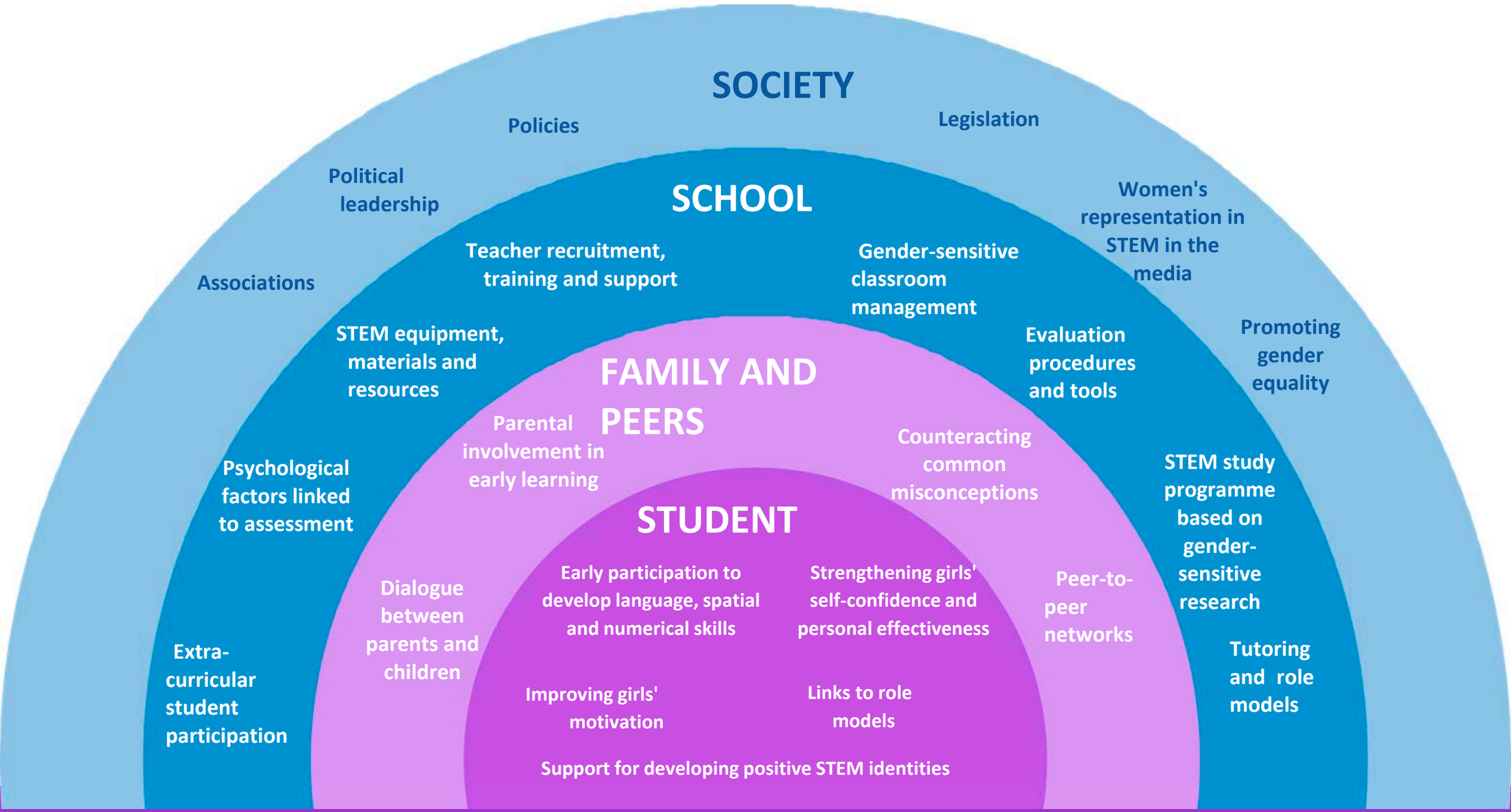




Gender stereotypes in the **media** affect **children and adults.**

Promoting women's interest in STEM

Interventions that help increase girls' and women's interest in and commitment to STEM education.



Interventions at school and on social level

SCHOOL

- **Improving** the system.
- Preparation of **teachers**, training, **mixed**.

VOCATIONAL GUIDANCE COUNSELLORS

- They can **increase** STEM **motivation** in girls.
- They can **collaborate** with family, friends and teachers.
- They can help with **school and family initiatives.**

BUILDING "SCIENTIFIC IDENTITY" AMONG GIRLS

- Explaining that **science is FOR EVERYONE**.

- **Avoiding hierarchy** of males.

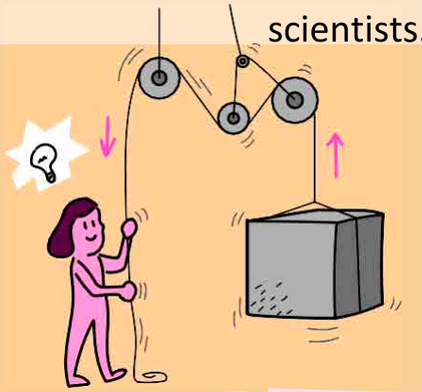
- **Involving girls** in practical and theoretical attitudes

- **Experiences**, laboratory, computers, technology...
- Extracurricular activities.

- Creating a **safe** and relaxed **atmosphere.**

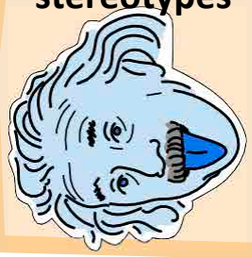
MUSEUMS, CENTRES, CAMPS, TRIPS...

Better understanding of the concepts scientists.



Learning through experience and **practical activities.**

Avoiding negative stereotypes

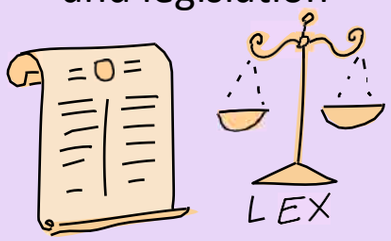


Providing professional **guidance** with a gender perspective.

INTERVENTIONS ON SOCIAL LEVEL

More SCHOLARSHIPS

Public policies and legislation



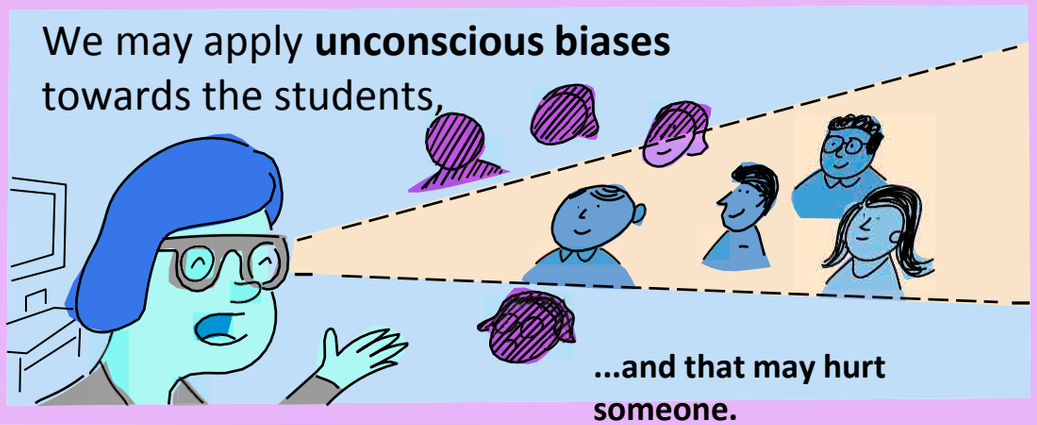
Positive images of STEM women

Creating partnerships

Recommendations for teachers

Let's know our STEAM biases

We may apply **unconscious biases** towards the students,



...and that may hurt someone.

Let‘s strive to locate if we treat some of them in a **Different way,**

or if we expect **something less** from some

We can record a video for **analysis**.

Let's build trust

Showing **confidence in** their **abilities** is positive for learners.

Let's take advantage of the interests of the students

We can build bridges between your out-of-school interests and STEM experiences.

We encourage students to express their ideas in a different way: presentations, role-playing, drawings, etc.

Let's group them in a different way

In STEM activities, let's offer them the opportunity to work with boys and girls from **different** backgrounds and languages.

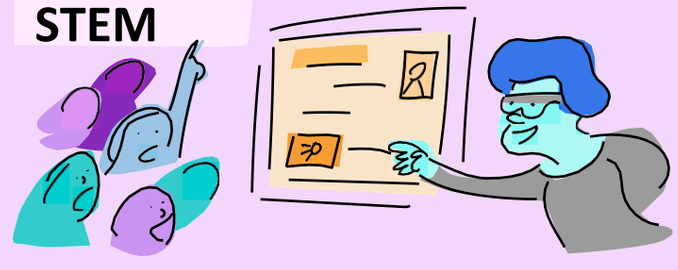
Let‘s present examples of STEM professionals

Let's show students **examples of diversity**, avoiding the stereotype of the brilliant scientist.

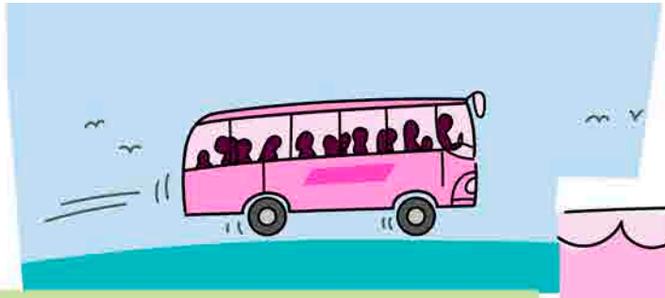
Let's promote contact between students and STEM professionals (if possible, not just white males), at school and at work

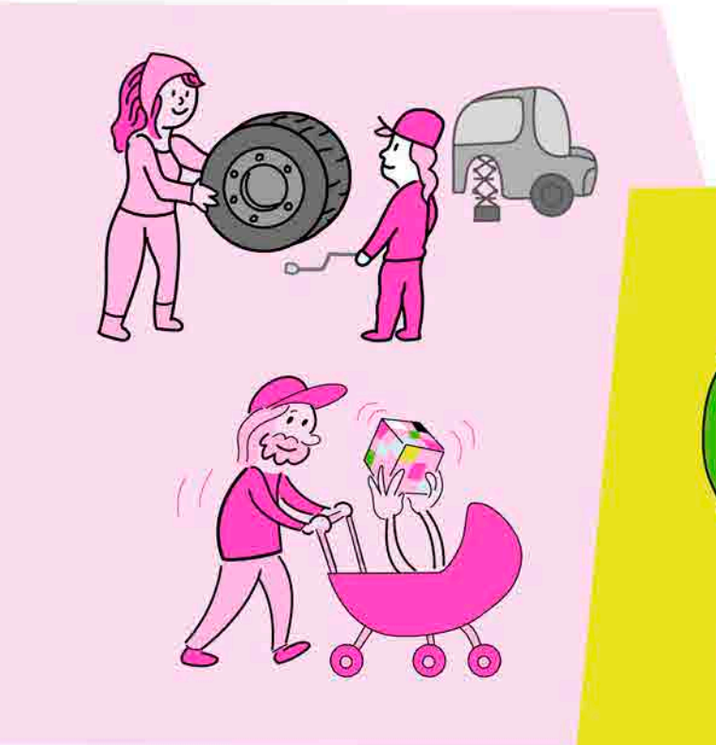
Prepare a short personal interview (motivations, etc).

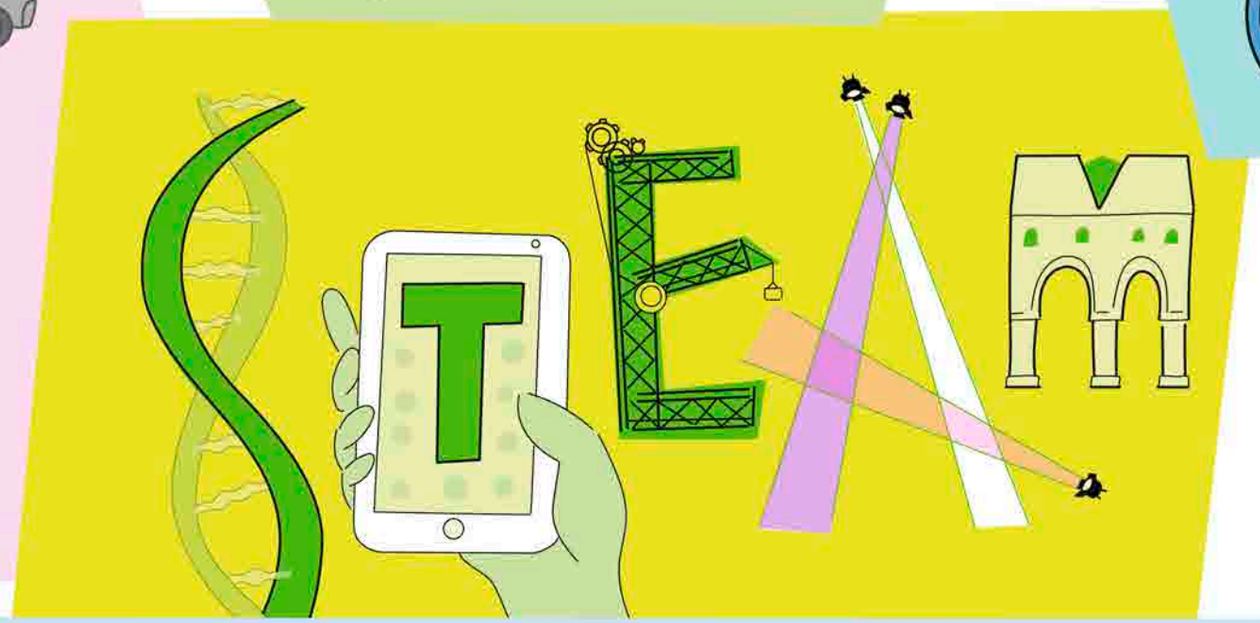
Let's analyse news about STEM



Let's go over them with the students, taking into account gender, diversity, etc.







EXPERIENCES AND COMMUNITY

elhuyar

Gipuzkoako Foru Aldundia
Ekonomia Sustapeneko, Turismoko eta
Landa Inguruneko Departamentua