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DEVELOPING *FUTURE-SCAFFOLDING SKILLS*: PILOT-STUDY ON A TEACHING/LEARNING MODULE ABOUT CLIMATE CHANGE AND PROJECT DESIGN

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Phenomenon observed also during science (physics) classes

- the (objective) difficulties of the younger generations to cope with an unpredictable future and with the global challenges of this changing and fragile world (*viewless/**invisible horizon***);
- the difficulties to find in the past clues to interpret the present (***speechless past***);
- the experience of a frantic present, completely oriented toward seizing the moment, sniffing out every opportunity, and keeping open all possible scenarios (***frenetic standstill***; *present as "dust of moving splinters"*, C. Leccardi).

"Society of acceleration" (Rosa, 2013)

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How can the contents of science be reconstructed so as to make disciplinary learning a place to develop skills to deal with time (future and, hence, past and present)?

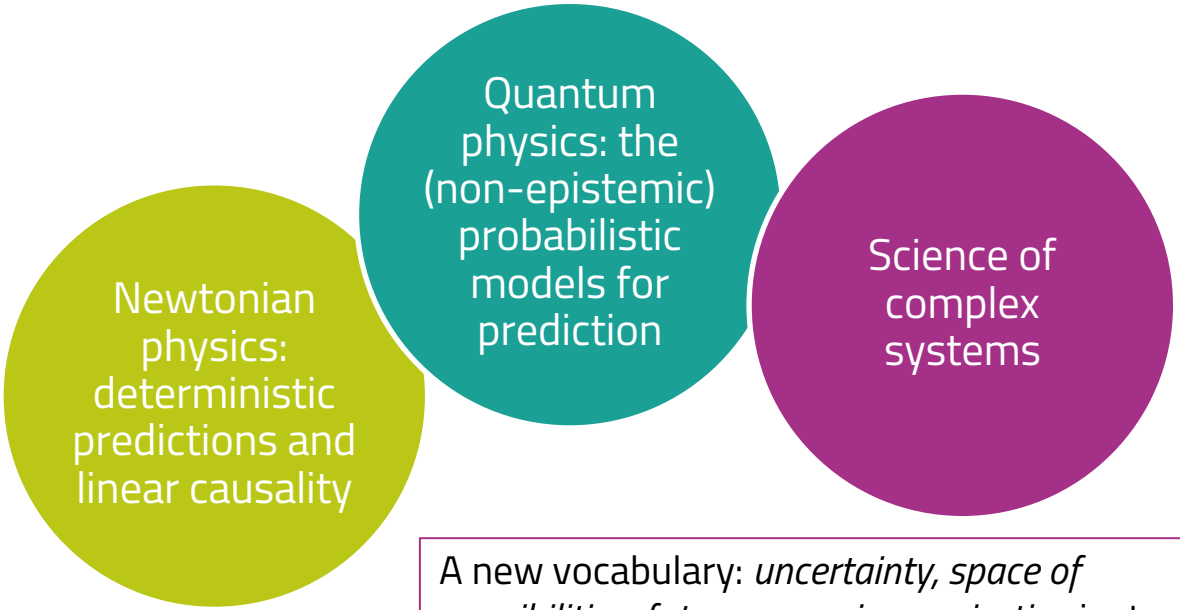
Future in science

- Future is intrinsic to science;
- Future is absorbed and integrated into the epistemological structure of science and is closely linked to the models of causal explanation gradually elaborated by science.

"We have acquired many certainties through ***science but twentieth-century science has also revealed many areas of uncertainty.*** *Education should include* ***the study of uncertainties that have emerged in the physical sciences (microphysics, thermodynamics, cosmology), the sciences of biological evolution, the historical sciences****."*

(E. Morin, The seven complex lessons in education for the future, 2001)

For example, future in physics



A new vocabulary: *uncertainty, space of possibilities*, *future scenarios*, *projection* instead of *deterministic prediction*, *feedback* and *circular causality…*

Future in transversal skills

Future is intrinsic to skills that are highly recommended by future studies, sociological studies and required by labour market (soft skills).

Examples are: *strategic thinking and project planning, risk taking, creative thinking, the distinction between probable, possible or preferable (or between expected, plausible and desirable) futures…*

Design principles

1. To develop future-scaffolding scientific skills

To value and flash out, in science teaching, the **scientific concepts** related to temporal patterns and causal modelling (including **concepts of the science of complex systems**) and turn them into skills to think and to talk about future

2. To develop future-scaffolding transversal skills

To enrich science teaching with activities aimed to develop skills that come from **future studies, sociology and labour market** and that can support students to push imagination toward the future

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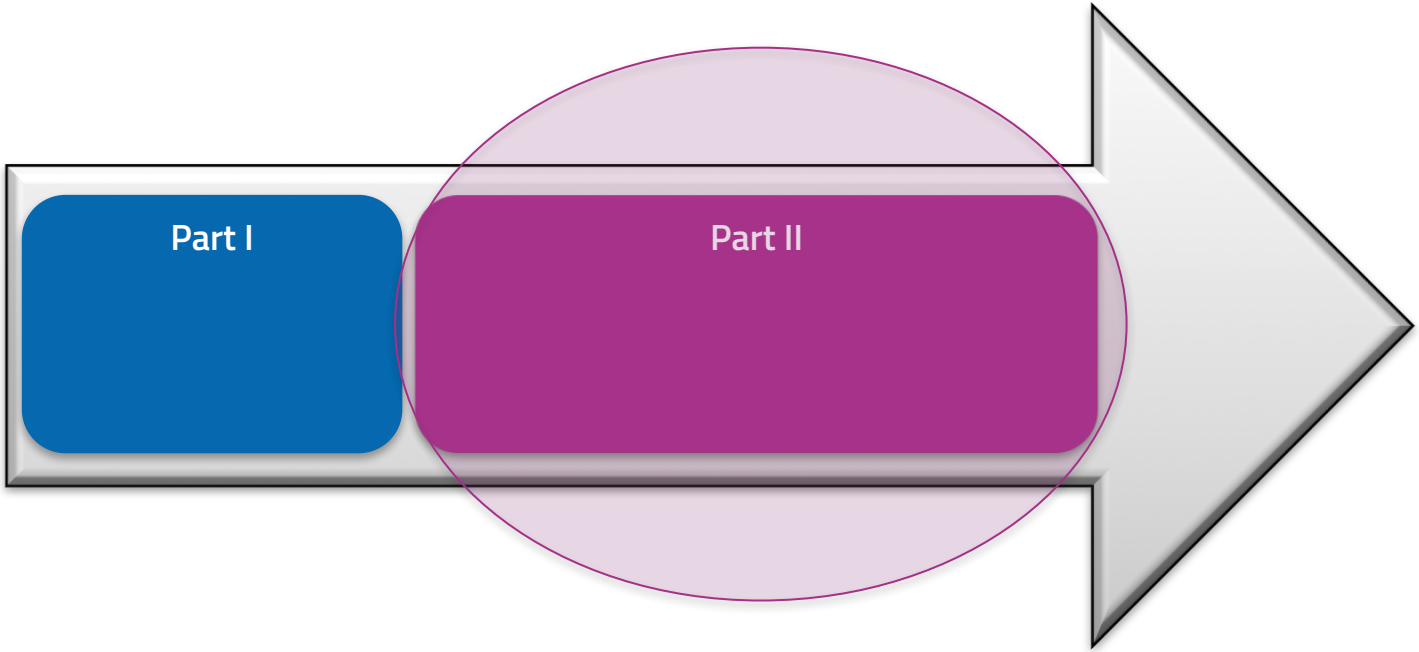
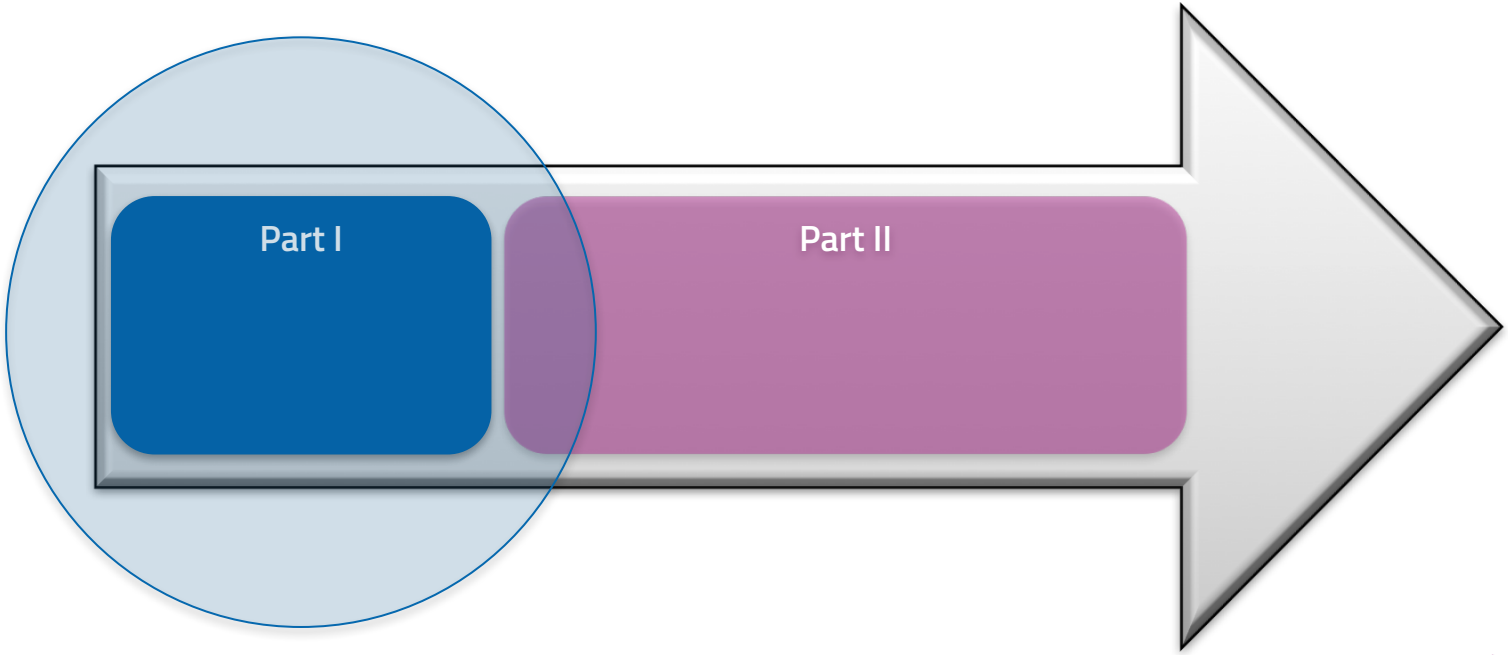
The teaching module

- focused on causal modelling in climate science (as follow up of the thermodynamics unit)
- targeted to secondary school students (grade 12th, 17-18 years old)
- enriched with activities on project planning
- lasting about 20 hours

The module (about 20 hours)



AIM 1: To enhance students' knowledge on climate change and develop **future-scaffolding scientific skills**



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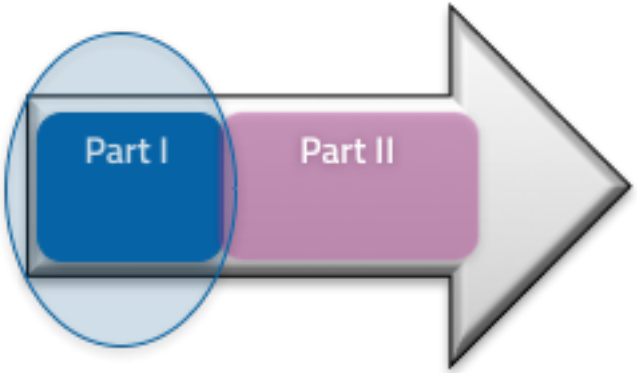

In particular, the activities of Part I aim to guide the students to:

i. understand the energy balance mechanism behind the greenhouse effect;
ii. grasp the concepts of circular causality and positive and negative feedback;
iii. understand the concept of scenario, the difference between prediction and projection;
iv. become familiar with the language of the IPCC reports (*Intergovernmental Panel on Climate Change*)

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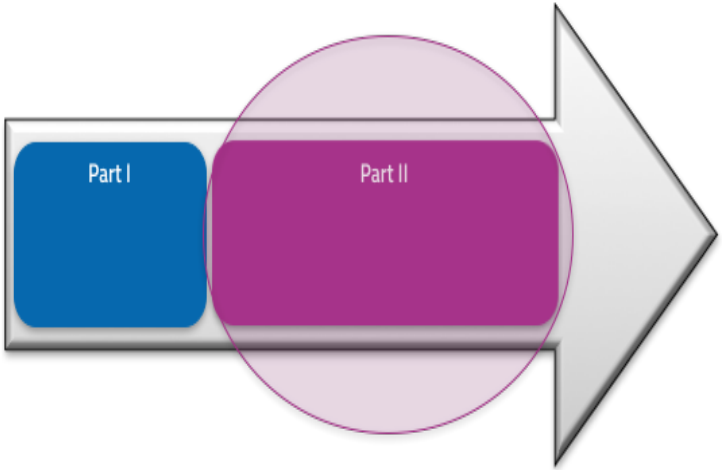
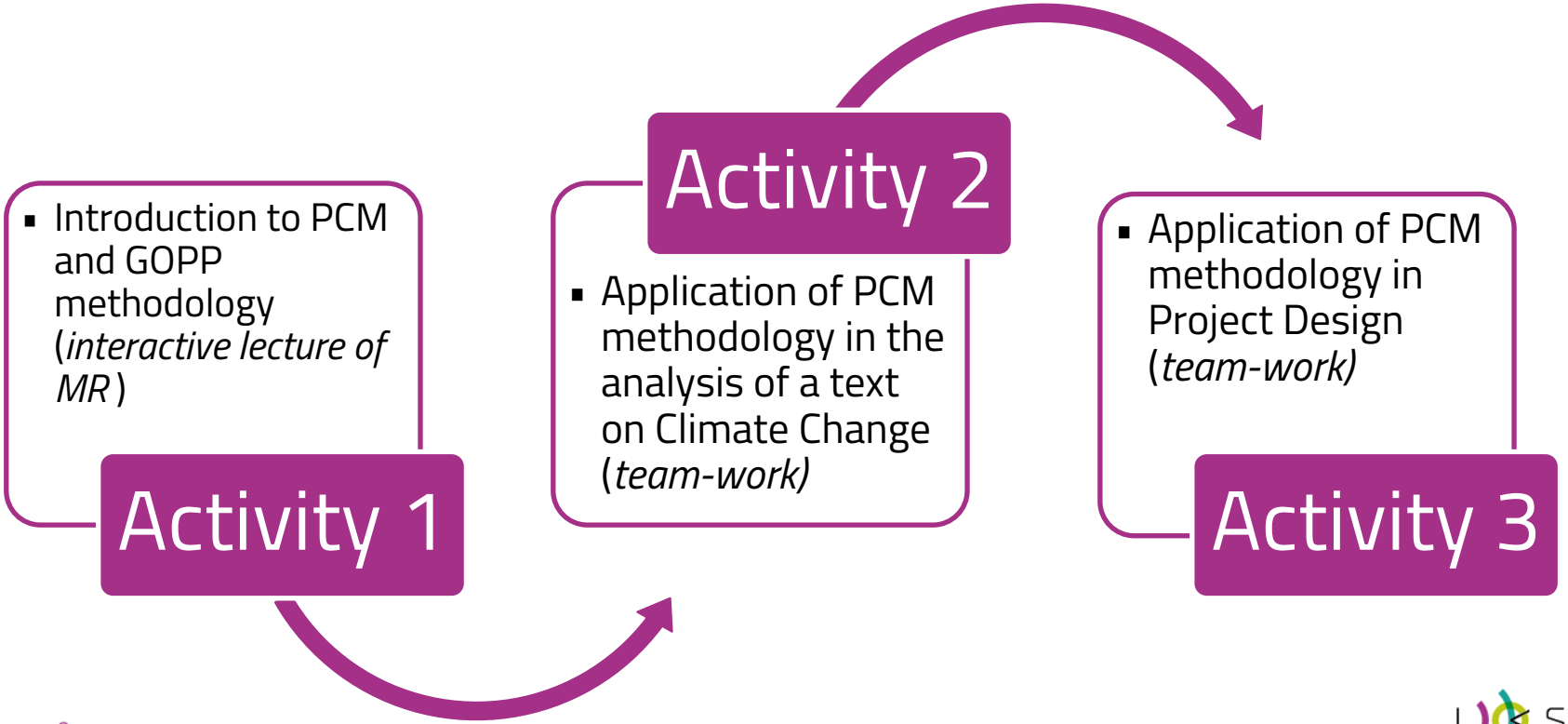
Aim 2: To develop
future-scaffolding transversal skills

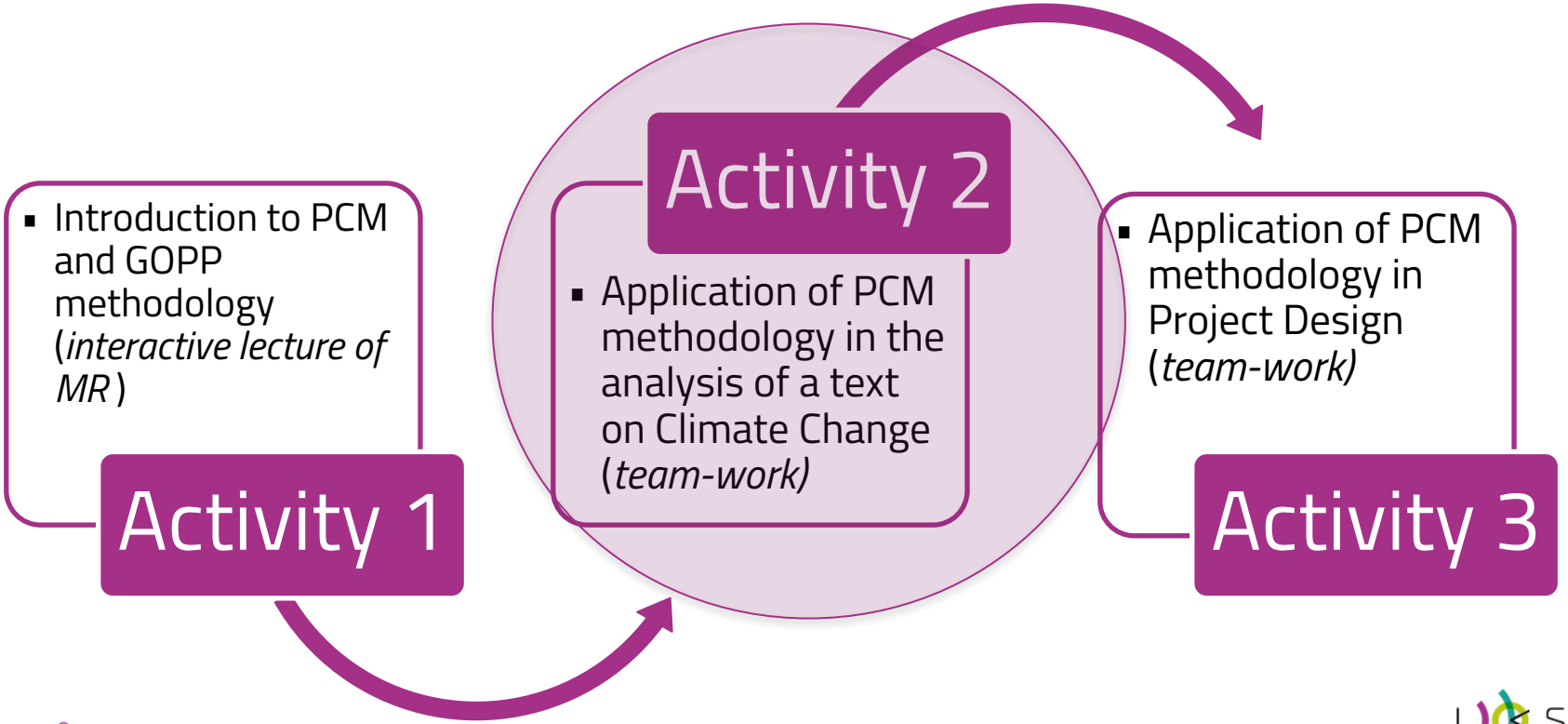


From **Project Cycle Management** (PCM): an analytical and managerial tool of ***project planning***, originally developed by NASA and currently widely used by various international NGOs and within European programmes such as Horizon 2020, consistent with the methodologies of **Goal Oriented Project Planning** (GOPP)

Activities of Part II



Activities of Part II

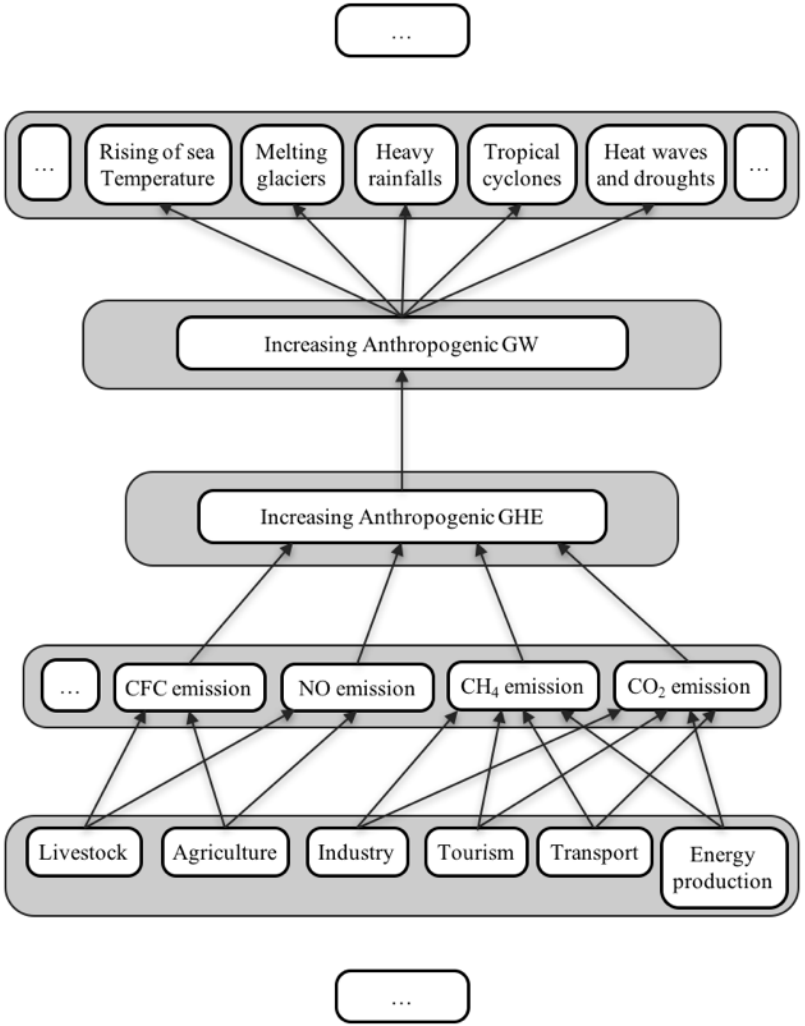


Analysis of the present (text analysis)

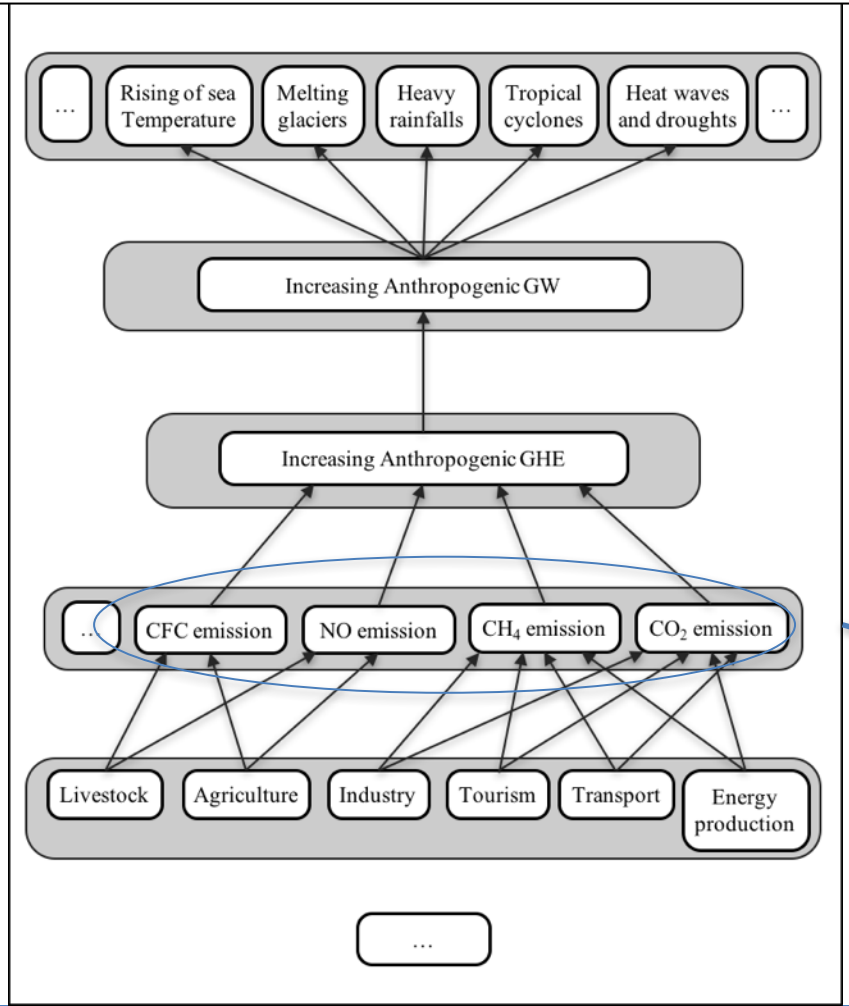
I. Construction of the ***Problem Tree***

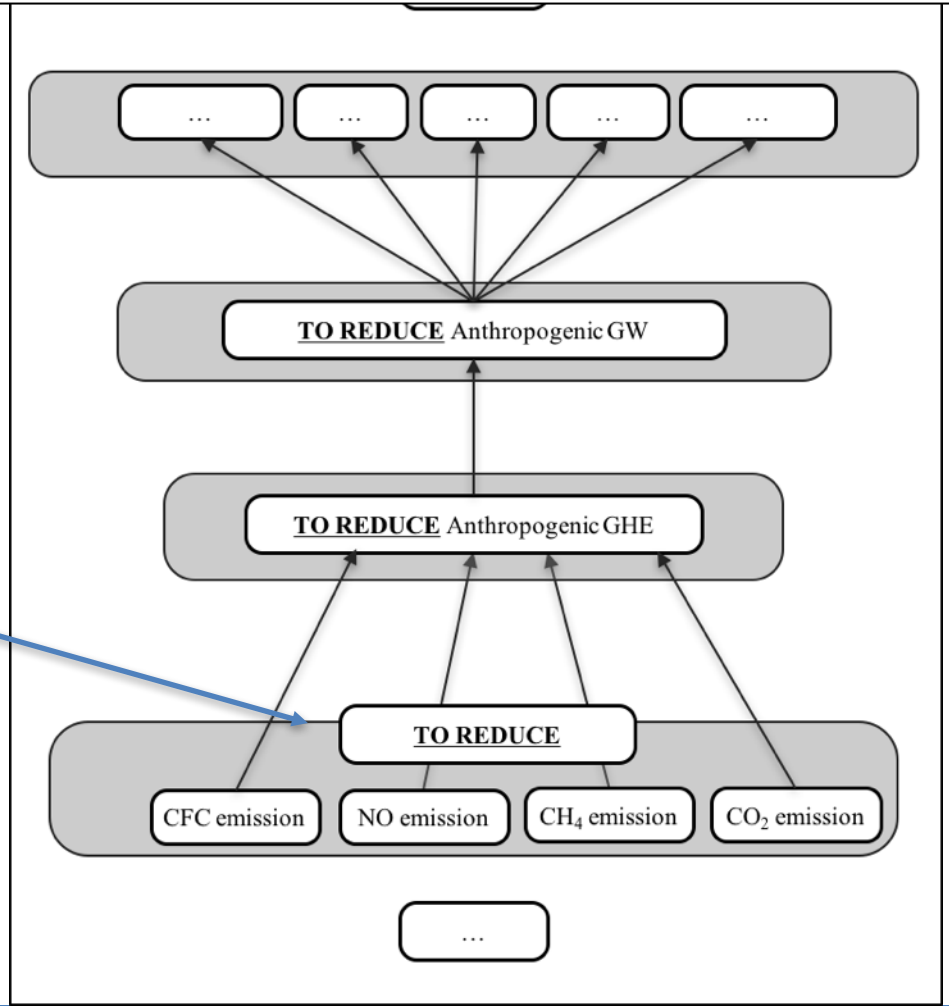
THE GLOBAL WARMING ISSUE

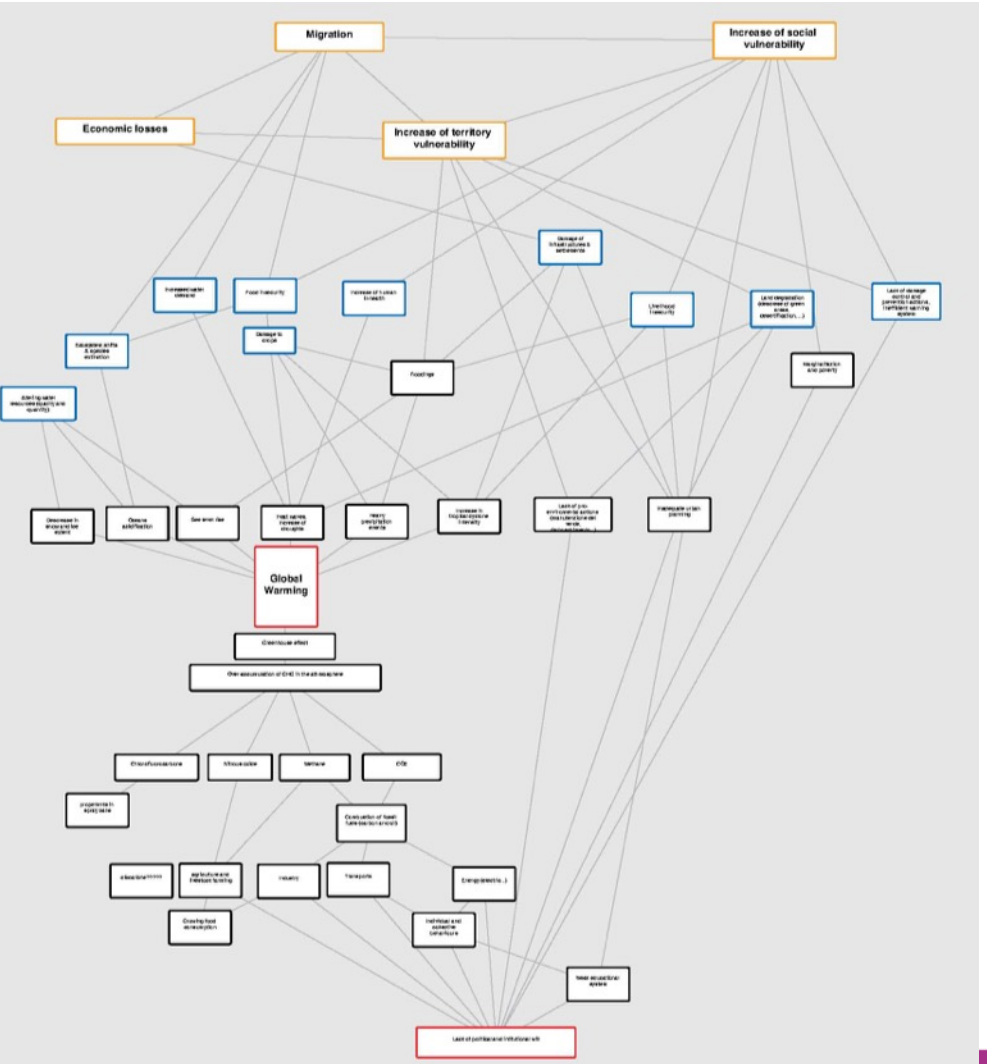
Global warming, in climatology, indicates an increase in the average temperature of Earth's surface and recorded in different phases of the climatic history of the Earth. The expression is now almost always used to mean heating due to the anthropogenic (i.e. human) contribution, decisive in the heating phase of the last 100 years. The fifth report of the *Intergovernmental Panel on Climate Change* (IPCC) in 2014 estimated that the average global surface temperature has increased by 0.85 [0.65-1.06] °C in the period 1880-2012. Most of the phenomena that cause the rise in temperature since the mid-twentieth century are considered, within the IPCC report, anthropogenic. These phenomena are responsible for an increase of the natural phenomenon of the greenhouse effect. The natural greenhouse effect is part of the complex of thermal equilibrium adjustment mechanisms of a planet (or satellite) surrounded by an atmosphere, which, if it contains certain gases called greenhouse gases, produces in fact the overall effect of mitigating the temperature the global average surface of the planet, isolating partially by large swings in temperature or that would subject the planet in their absence. To give an idea of the phenomena regarding the Earth, in the absence of greenhouse gases, by the equation of balance between in- and outgoing radiation is one which average surface temperature of the Earth would be of about -18 °C whereas, thanks to the presence of greenhouse gases, the actual value is about +14 °C, enabling life as we know it. The greenhouse effect that increases the natural greenhouse effect is that phenomenon due to the emission of greenhouse gases by human activities, including industry, agriculture, livestock, transport, power plants for civilian purposes. In particular industries, transport, energy production facilities and even tourism activities contribute to increasing emissions of carbon dioxide (CO2) and emissions from fossil fuels such as methane. Agriculture and livestock, that are more and more intensive activities because of the growing food demand, contribute most to the emission of nitrous oxide and methane. Most production of methane is in fact due to the fermentation of typical livestock manure, that also grew significantly, and the fermentation of crops to submergence (for example rice). To the list of greenhouse gases should be added the chlorofluorocarbons (CFC), the only man-made gas, mainly used in the production of spray cans. This type of cans, now banned from production in different countries, have been the subject of debate between eighty and two thousand years as they are considered responsible for the depletion of the ozone layer in the atmosphere. […]



II. Transformation of the *Problem Tree* in an *Objetive Tree*







The text (and hence complete causal map), as well as the problem of GHGs emissions, includes:

- problems relating to political negotiations;
- urban, territory and social vulnerability,
- climate migrations,
- the lack of scientific literacy,
- insufficient citizenship engagement, and so on.

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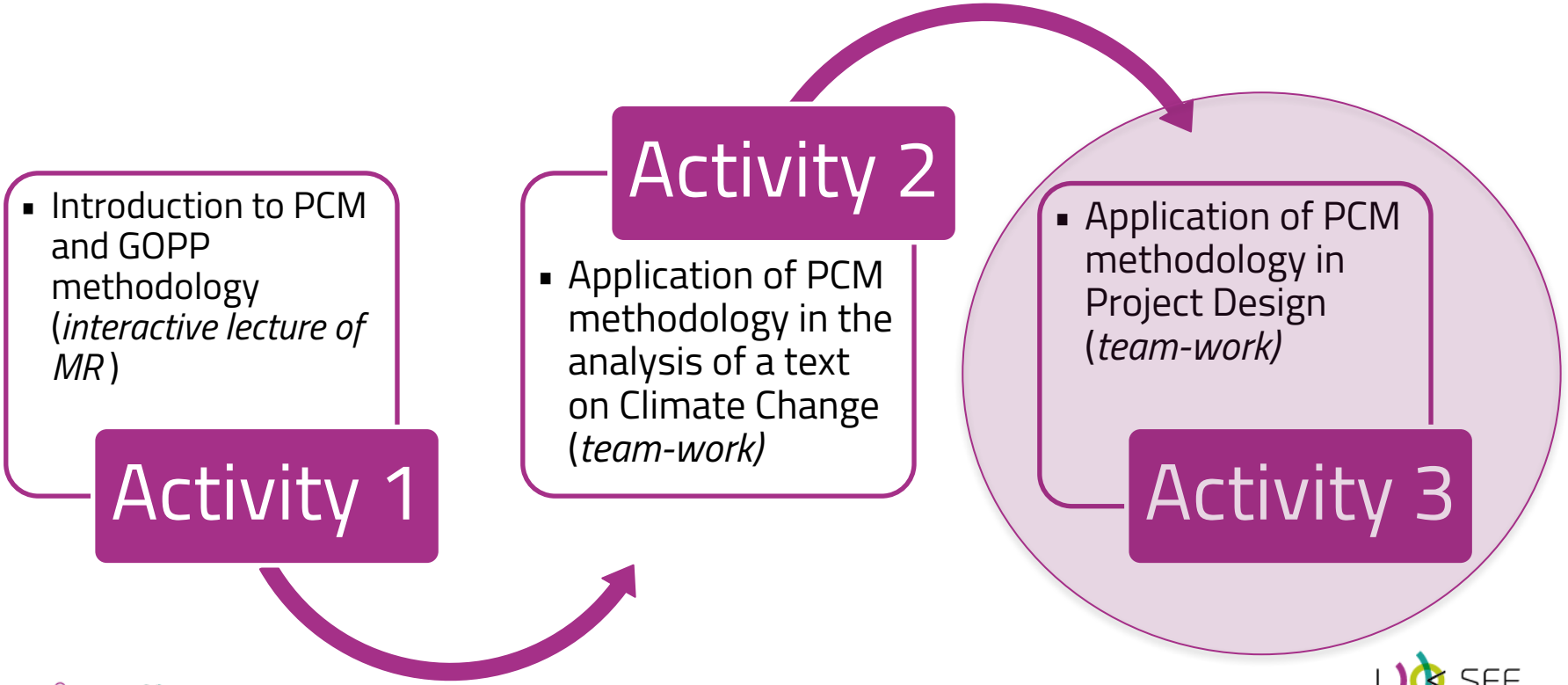
Activities of Part II



CALL: Rimini, the ideal future city in which living

As claimed in the IPCC report, two types of actions are required in order to address problems related to climate change: i) action in the form of *mitigation*, i.e. action aimed at developing research and technological innovation to reduce the emission of greenhouse gases, as well as actions to convince all actors who are responsible for these emissions to reduce them; ii) action in terms of *adaptation*, i.e. actions aimed to decrease, if not the hazard of the events, social vulnerability, as well as the exposure and vulnerability of the regions.

As far as adaptation actions is concerned, they can be of different types: structural (e.g. measures to protect the environment and securing the sites as well as measures to ensure an adequate urban planning); social, (e.g. measures to reduce the poverty or marginalization of some social groups so as to reduce their social vulnerability); cultural (e.g. education, dissemination and capacity building actions aimed at changing the attitude of individuals and the community toward the complex phenomenon of climate change and its environmental, economic, political and social implications).

Team-work is required to build a **3-year** project where multi-dimensional actions of mitigation and/or adaptation have to be planned in order to transform Rimini into an ideal future city in which to live.

The project must contribute to achieving at least two general objectives from among the following:

1. Imagining innovative forms of urban planning (***smart cities***) with the help of ICT tools (***information and communication technology***) in order to ensure sustainable development and a better quality of life (housing security, transport, green areas, *etc.*);
2. Promoting active citizenship actions (***public engagement***) on climate change issue in areas at high risk both of social and economic marginalization and of social vulnerability;
3. Influencing ***policy makers*** to promote policies that encourage **mitigation and/or adaptation actions** in the economic-productive, scientific and social realms;
4. Promoting information, communication and/or education strategies aimed at encouraging a cultural change related to climate change and the diffusion of **scientific citizenship competences**;
5. **Reducing the emissions** produced by one or more of the major players in the business world (industry, agriculture, energy, tourism, fishing ...) by influencing their behaviour.

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Template

TEMPLATE

1) TITLE (use also an acronym)

2) OBJECTIVES (1 page of description and graphical representation)
Describe what the overall objectives of the call (from 1 to 9) the project refers and describe the specific objectives of the project with any sub-objectives

3) "CONCEPT" (1/2 pages)
Describe the central idea that characterizes the project and gives coherence to the multidimensionality of the objectives and activities.

4) TEAM
Describe the composition of the participants using the table below

Table 1 – THE TEAM

Physical or legal person (e.g., association / organization)	Skills and type of expertise	Role in the project

5) SET OF ACTIVITIES SCHEDULED FOR THE GOALS AND DIFFERENT TARGET GROUPS
Describe how they intend to meet the objectives and target groups, using the table below

Table 2 - Set of activities and target group

What (specific objective)	How (Activity*)	To Whom (Target Group)
OB1 SO 1.1 … SO1.n	 A 1.1.1 A 1.1.2 … A 1.n.1 …	
OB2 SO 2.1 … SO2.n	 A 2.1.1 A 2.1.2 … A 2.n.1	
…		
OBm SO m.1 … SOm.n	 A m.1.1 A m.1.1 … Am.n.1 …	

(*) To describe the set of activities, take as reference the strategic actions contained in the call and organize them in packets of useful activities able to achieve the goals or the sub-goals.

6) STAKEHOLDERS (1/2 pages)
Identify the actors (different form the target groups), which must be involved in the project to maximize the probability of success and describe the type of involvement (why and how you plan to involve them).

7) GANTT CHART
Illustrating the temporal organization of the activities by using the GANTT CHART attached.

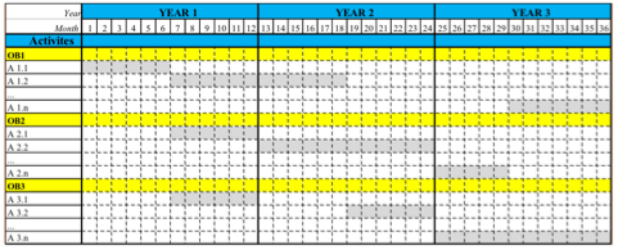


Figure 1 – prototype of a filled in GANTT CHART

8) IMPACT (1 page)
Describe how the project results will contribute to achieving the general objectives set out in the call and, more generally, to reduce the risk and/or the social vulnerability to climate change, by making Rimini the ideal city to live in 2030.

The pilot study

Context of the teaching experiment

- **School:** Scientific Lyceum “A. Einstein” in Rimini
- **Class:** IV B (grade 12th, 17-18 years old students)
- **Students involved:** 24/25 volunteer students (15 females and 9 males)
- **Teacher:** Professor Paola Fantini (co-author)
- **Position in the curriculum:** at the end of thermodynamics path
- **Length and nature:** 7 extra-curricular meetings, after-school time

Data collection

MAIN DATA SOURCES	MOMENT OF SUBMISSION			CHECKED ISSUE/DIMENSION		
	B	D	E	CC	Imaginary	Creativity
Written essay (about future in 2030)	X	X		X	X	X
Projects made by group of students (5)		X	X			X
Audio-recorded of groups' work		X				X
Audio and video recorded of the meetings		X				
Researchers notes		X				
Individual semi-structured interviews			X	X	X	X

Legend of the table: ***B:*** *beginning of the path;* ***D:*** *during the path;* ***E:*** *at the end of the path*

One research question:
Did the module impact students' perception of the future? If so, how?

Data collection

MAIN DATA SOURCES
Written essay (about future in 2030)
Projects made by group of students (5)
Audio-recorded of groups' work
Audio and video recorded of the meetings
Researchers notes
Individual semi-structured interviews

Legend of the table: B: *beginning of t*

Imagine a spring day in 2030 and try to think of yourself in the place where you wish to live.

In one-two pages, describe:

The place where you imagine to live;

The objects, the house and immediate environment that surround you;

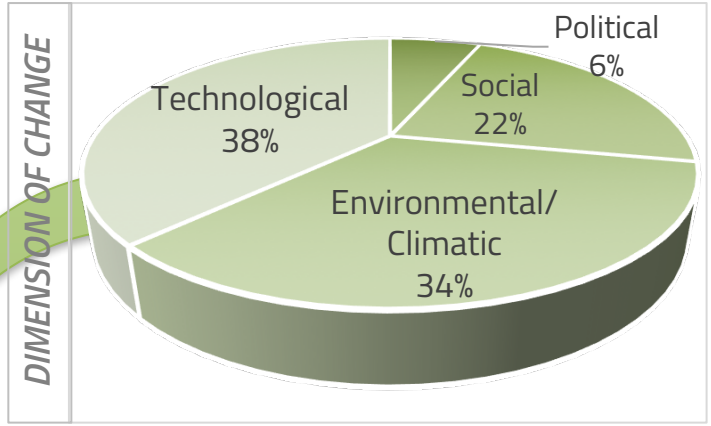
The type of life that you have;

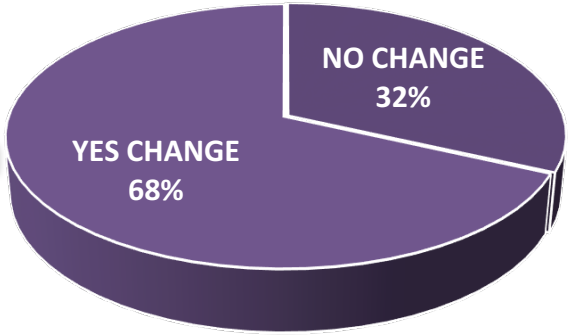
The types of problems that you and your community and society are facing and/or discussing;

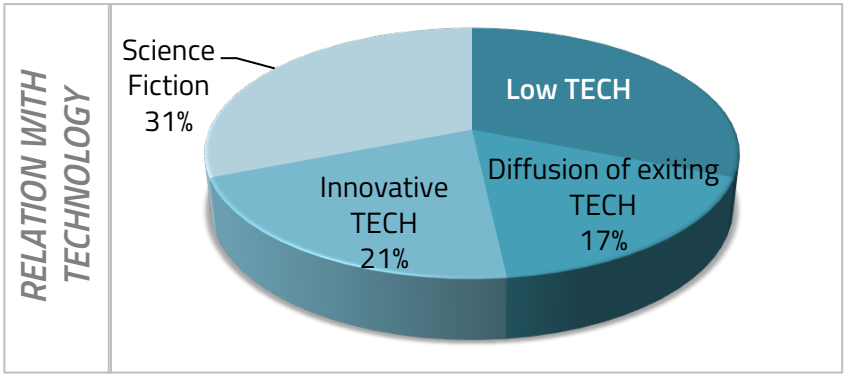
The chances and the new opportunities that you are available to you;

Students' imagine of *future* - BEFORE

... relation with changes







... attitude toward future and climate change

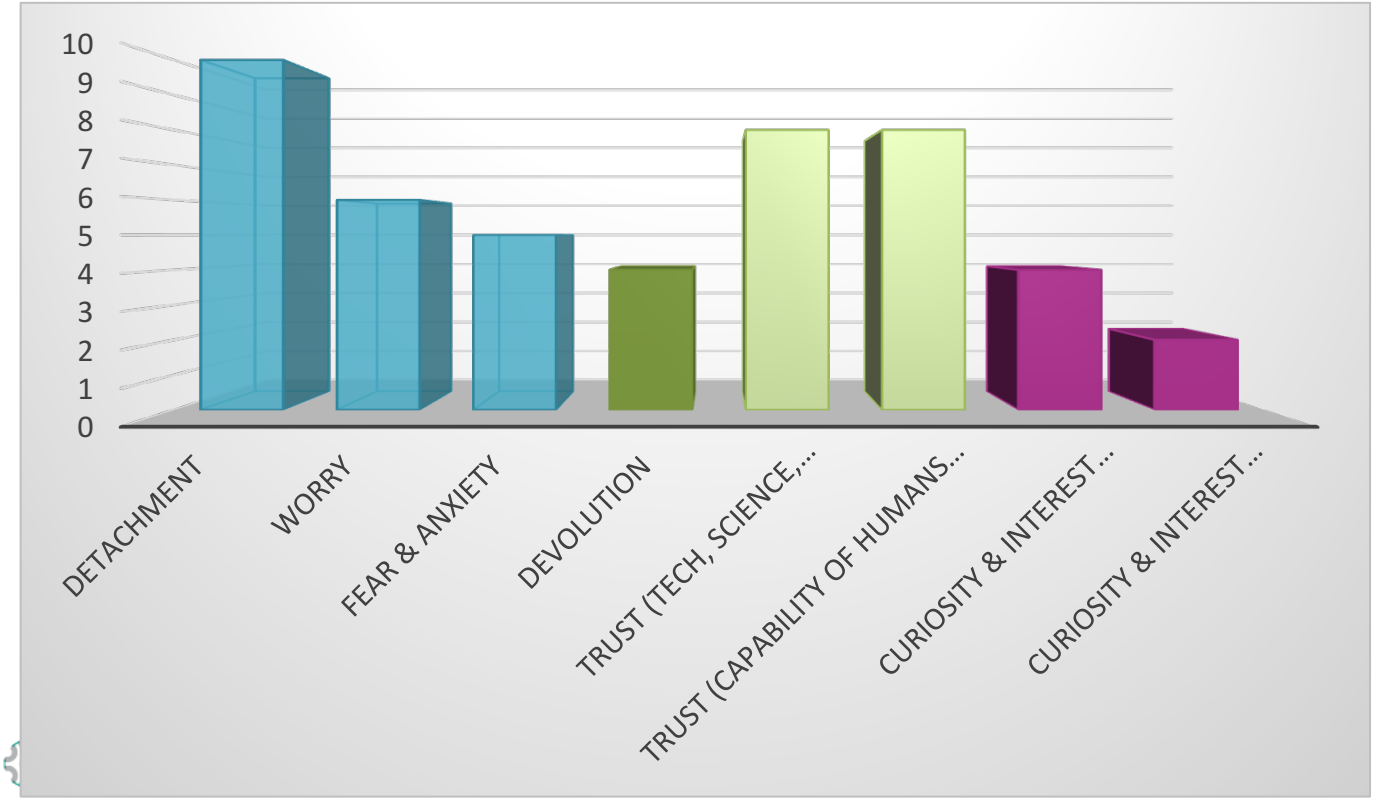
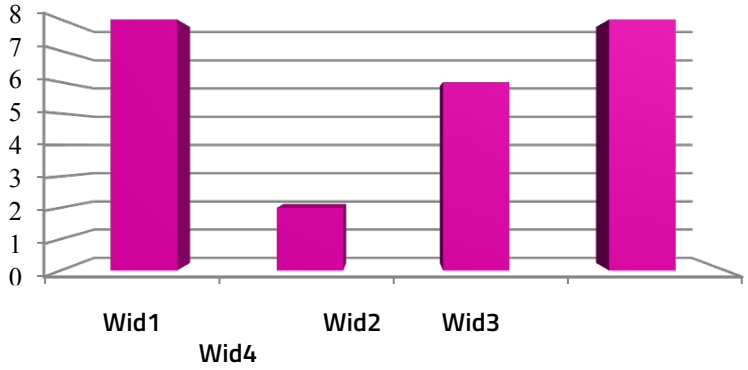


Image of *future* - AFTER

Emerging of a *scaffolding* that allowed
the view become clearer and wider
and the future closer

Scaffolding : WIDENING/ENLARGING & APPROACHING



Wid1: knowledge of the topic;

Wid2: range of possible actions;

Wid3: range of new ways of thinking and looking at the problem;

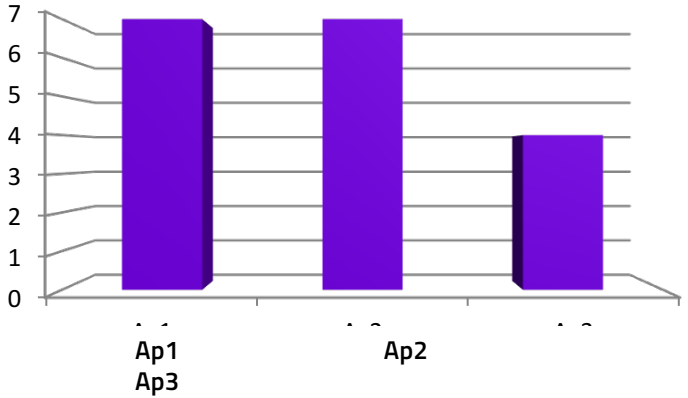
Wid4: awareness and confidence in their own potential and their role of agents.

The future became:

(Ap1) thinkable and imaginable;

(Ap2) concretely approachable through achievable actions;

(Ap3) within their reach.



“The project has helped us to think, ***to do something*** ***in relation to*** ***something else*** *[...] what I learned about* ***shifting from problems to goals*** *impressed me a lot, it also "woke me up", in the sense that often we perhaps see all the problems and do not see even one positive aspect, with this project we have seen that* ***things are feasible*** *and* ***they depend on how we act****. [...] If we are too focused on one thing, we cannot see it in a* ***global context****... instead we must always* ***have a vision which is both global and transversal****, and then of course, when necessary, we must be able to* ***explore details****, but always remember the context in which we are.”* (Elena)

Conclusion: The Main Result

Students significantly changed their perception of future : ***from far and unimaginable, it became thinkable as a bunch of possibilities, addressable through concrete actions and at their reach, in the sense that they found room to see themselves agents of their own future***.

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The project is co-funded by the Erasmus+ Programme of the European Union.
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The I SEE Project

Goal:

To design innovative approaches and teaching modules on STEM advanced topics, to foster students' capacities to imagine the future *(future-scaffoling skills)* and aspire to STEM careers.

Intellectual outputs

- teaching-learning modules
- guidelines for teachers
- research reports
- policy recommendations.

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- Youtube channel: https://www.youtube.com/channel/UCsw5RSFl3R8UsnKLeYb_Juw

Thank you for your attention

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