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Developing future-scaffolding skills through physics teaching at the secondary school level:

The I SEE European project

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The project is co-funded by the Erasmus+ Programme of the European Union. Grant Agreement n° 2016-1-IT02-KA201-024373.

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Our current research issue

How can the contents of science (physics) be reconstructed so as to make disciplinary learning a place to develop competencies to deal with the future?

Phenomena observed also in secondary school physics classes:

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

"Society of acceleration" (Rosa, 2013)

Challenging questions for science education researchers and teachers:

(i) how can physics teaching provide the students with opportunities to experience the present as a real moment of world understanding, sense-making and self-construction?

(ii) how can physics teaching contribute to developing competencies for managing, rationally and emotionally, uncertainty towards the future and to push imagination forwards?

(iii) how can physics teaching foster the development of a dialogue with a past able to grasp the present?

Challenging questions for science education researchers and teachers:

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(ii) (iii) …

1. Levrini O., Fantini P., Pecori B., Tasquier G., Levin, M. (2015). Defining and Operationalizing 'Appropriation' for Science Learning, *Journal of the Learning Sciences*, 24(1), 93-136,.
2. Levrini O., Fantini P. (2013). Encountering Productive Forms of Complexity in Learning Modern Physics. *Science & Education*, 22 (8), 1895–1910.

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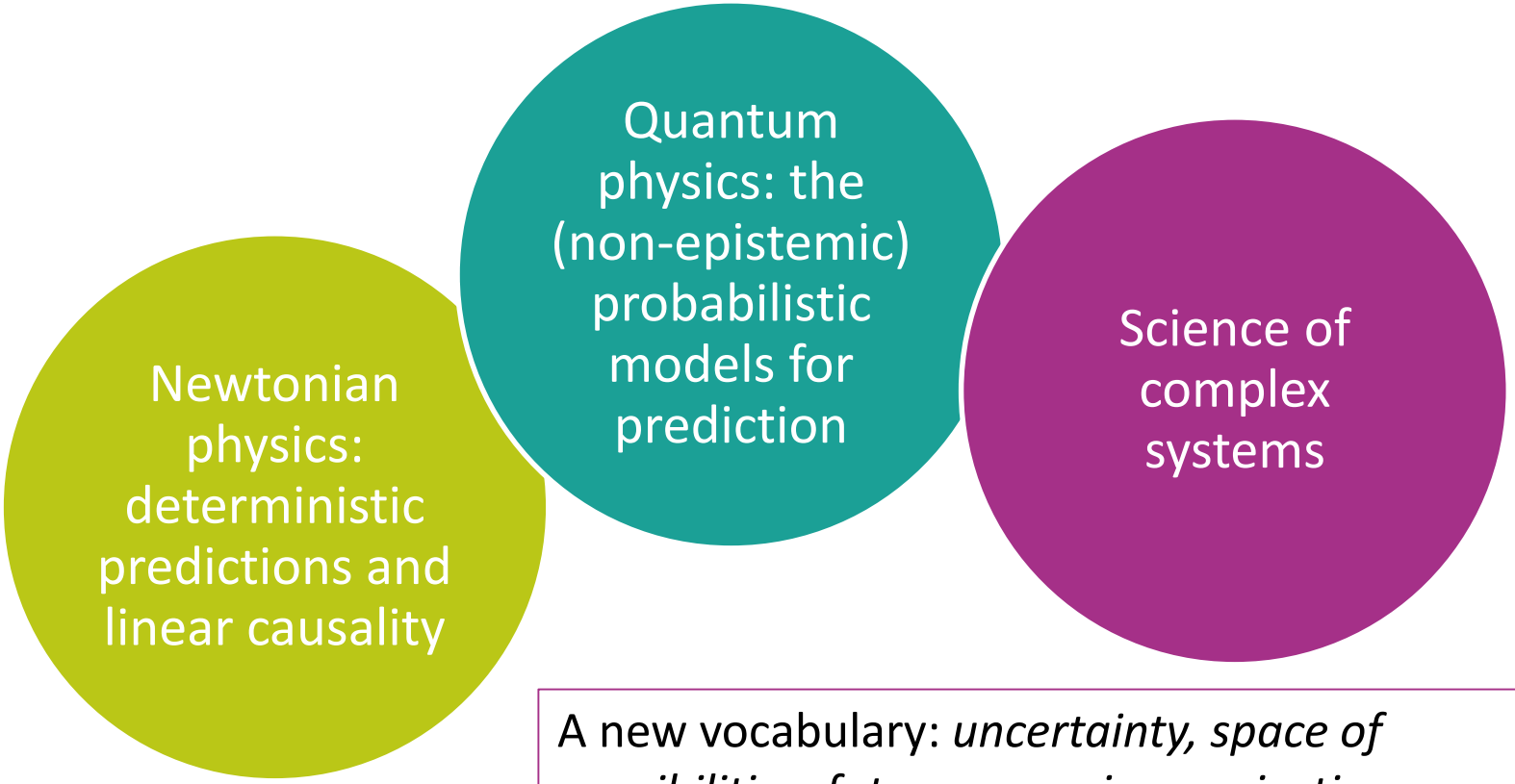
Future in science

- Future is intrinsic to science;
- Future is absorbed and integrated into the epistemological structure of physics 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)

Future in science



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

Future-scaffolding skills:

abilities that enable students to construct visions of the future that empower action in the present with an eye on the horizon

Future-scafolding scientific (-hard) skills: scientific concepts that can be turned into skills to support a new way to think and to talk about future (*uncertainty, space of possibilities*, *future scenarios*, *projection* instead of *deterministic prediction*, *feedback* and *circular causality)*.

Future-scaffolding transversal (-soft) skills: transversal skills that come from future studies, sociology and labour market (soft skills) and that can support students to push imagination toward the future (e.g. *strategic thinking and planning, risk taking, possibilities thinking, managing uncertainty, creative thinking, modelling and argumentation.)*

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Goal: to design innovative approaches and teaching modules to foster students' capacities to imagine the future (future-scaffoling skills) and aspire to STEM careers.

Intellectual Outputs: In order to realize future-scaffolding skills in STEM education, the I SEE partnership will develop innovative **teaching-learning modules** and **guidelines for teachers**, **research reports** and **policy recommendations**.

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Partners

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Pre- I SEE module & results from a pilot-study

Context of the teaching experiment

- **School:** Scientific Lyceum “A. Einstein” in Rimini (our partner)
- **Class:** IV B (grade 12th)
- **Teacher:** Professor Paola Fantini
- **Position in the curriculum:** at the end of thermodynamics path
- **Kind of meetings:** 7 extra-curricula, after-school time, only for volunteers
- **Students involved:** 24/25 (15 females and 9 males)
- **Research group:** Laura Branchetti, Paola Fantini, Olivia Levrini, Monica Russo, Giulia Tasquier, Ilaria Venturelli

Aims (1/3)

- To enhance students' knowledge on climate change and develop a critical and rational attitude about the debate on the topic

- To develop skills in "European Project Planning" consistent with the methodologies of Goal Oriented Project Planning (GOPP) requested from the labor market

- To transform "Project Planning" skills in tools for structuring thought in order to let students imagine their future

Aims (2/3)

- To enhance students' knowledge on climate change and develop a critical and rational attitude about the debate on the topic

In particular, the students were guided to:

i. understand the energy balance mechanism that lays behind the greenhouse effect;
ii. grasp the concepts of circular causality and feedback;
iii. understand the role and the specificity of the modelling in the analysis of complex systems, such as 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*)

Aims (3/3)

- To enhance students' knowledge on climate change and develop a critical and rational attitude about the debate on the topic

- To develop skills in "European Project Planning" consistent with the methodologies of Goal Oriented Project Planning (GOPP) requested from the labor market

- To transform "Project Planning" skills in tools for structuring thought in order to let students imagine their future

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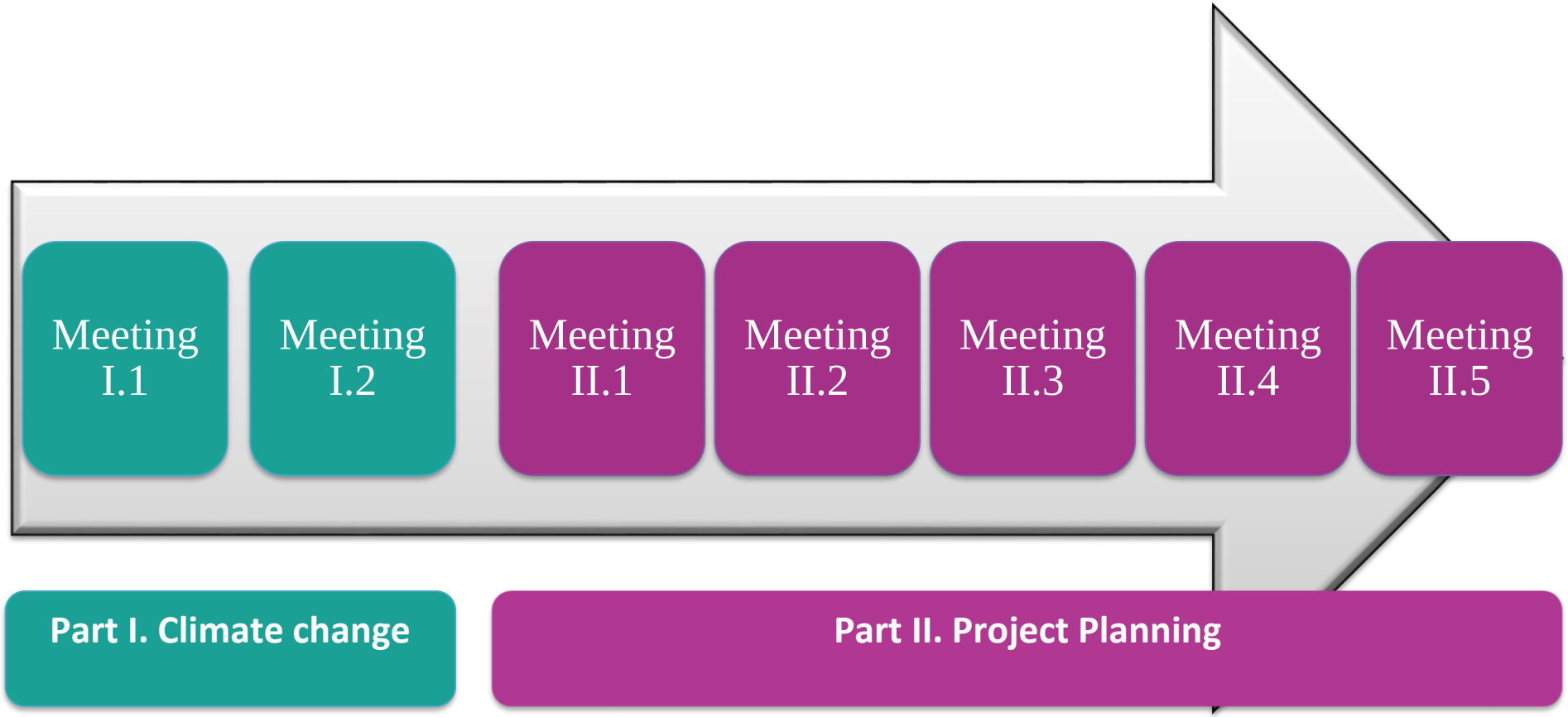
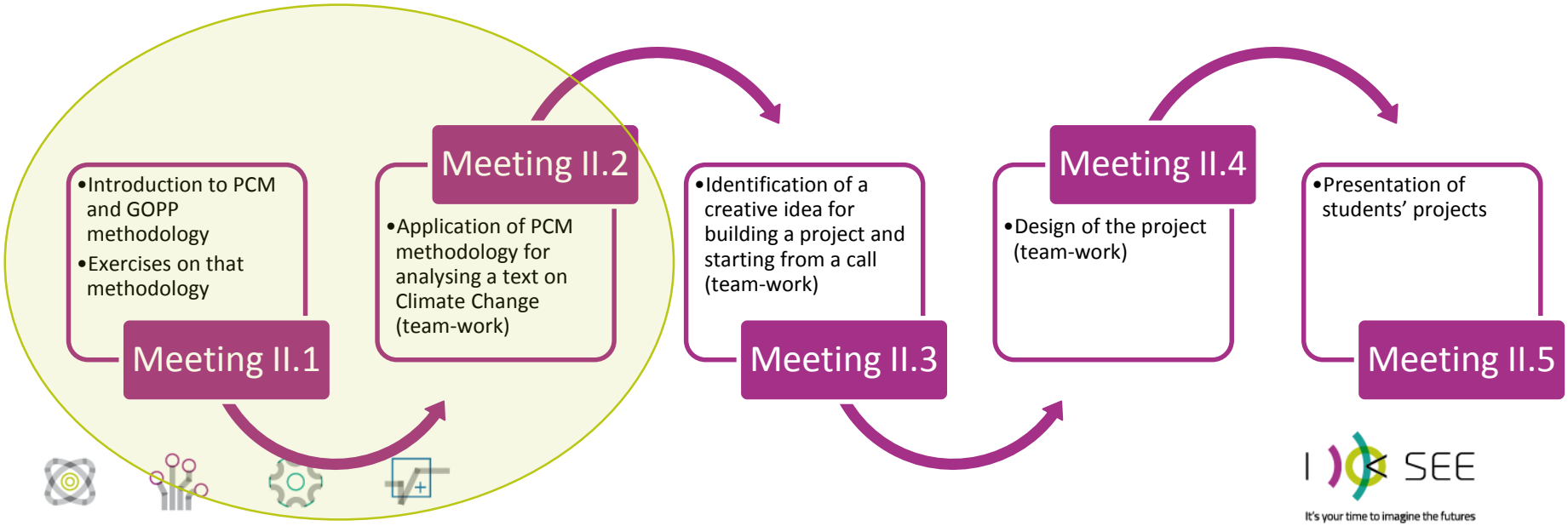
The “module”



(*) Extra-school meetings of 3 hours each

The “module”

Analysis of the “present situation” through the application of GOPP strategies: Four-phase analysis of a complex text, built as a summary of the IPCC reports



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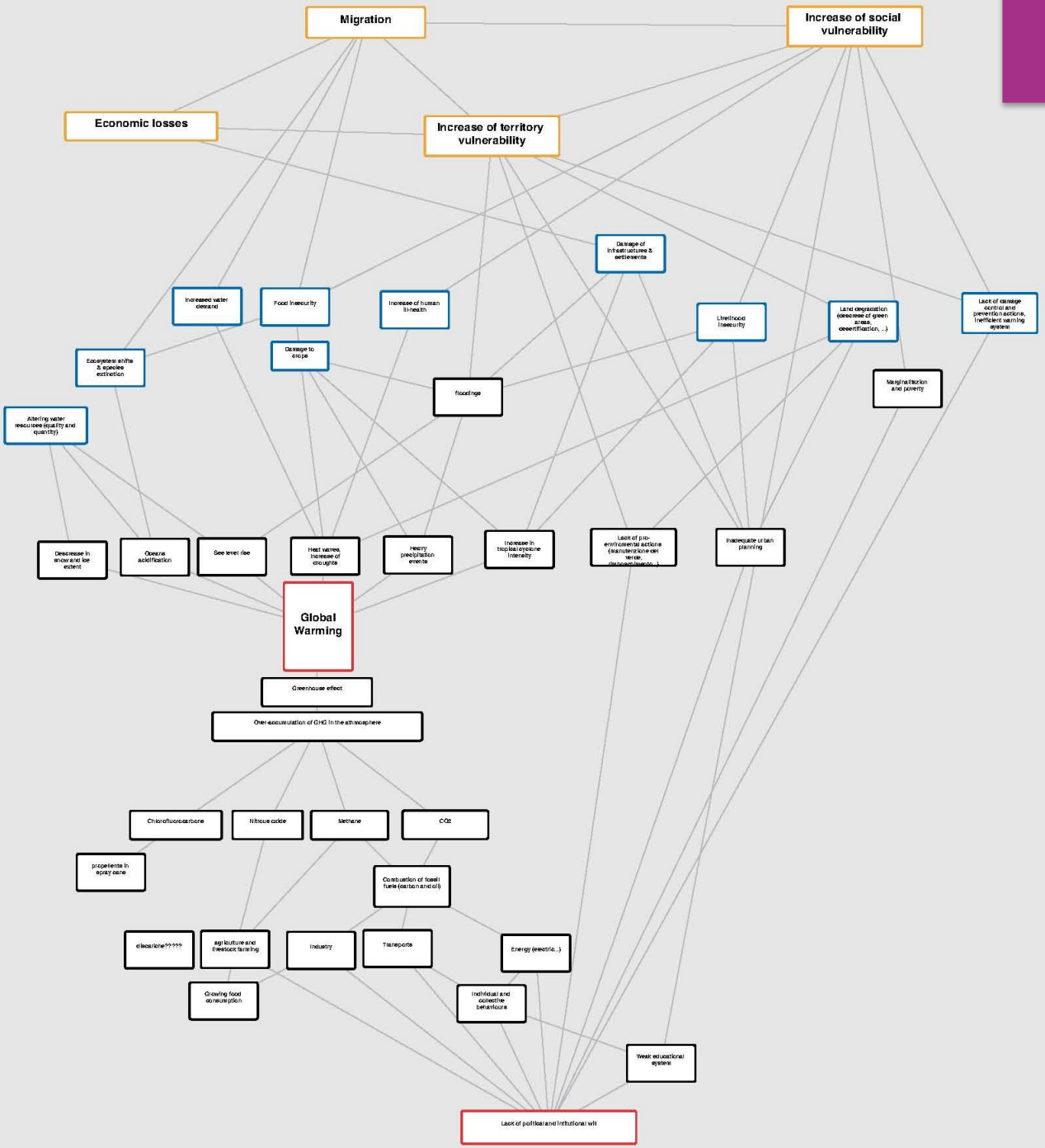
Phase I: Individuation of the problems and their causal relationships

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 with heating significance 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 in fact, produces 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. For giving 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. […]

Phase II: the construction of the “problem tree”



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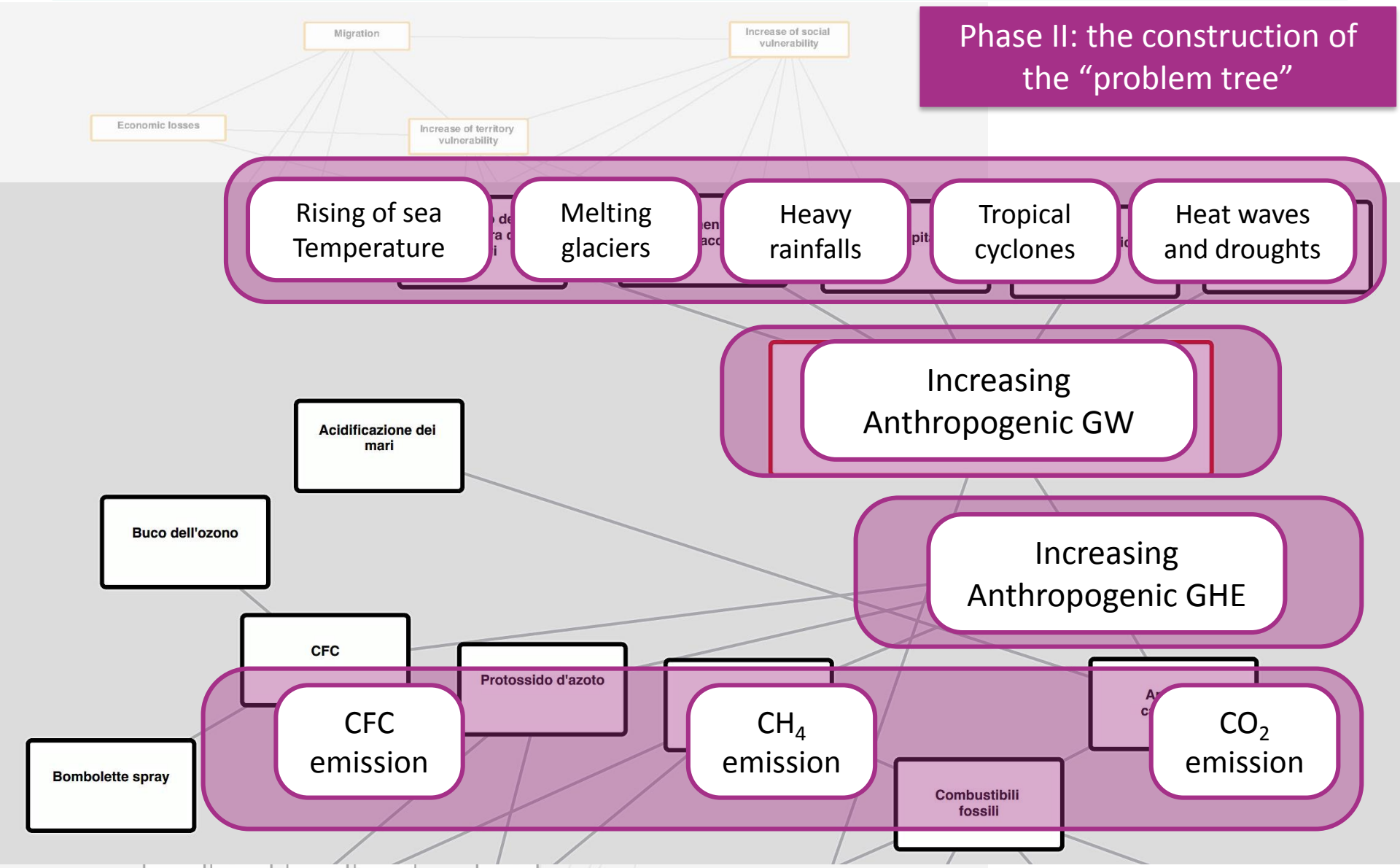

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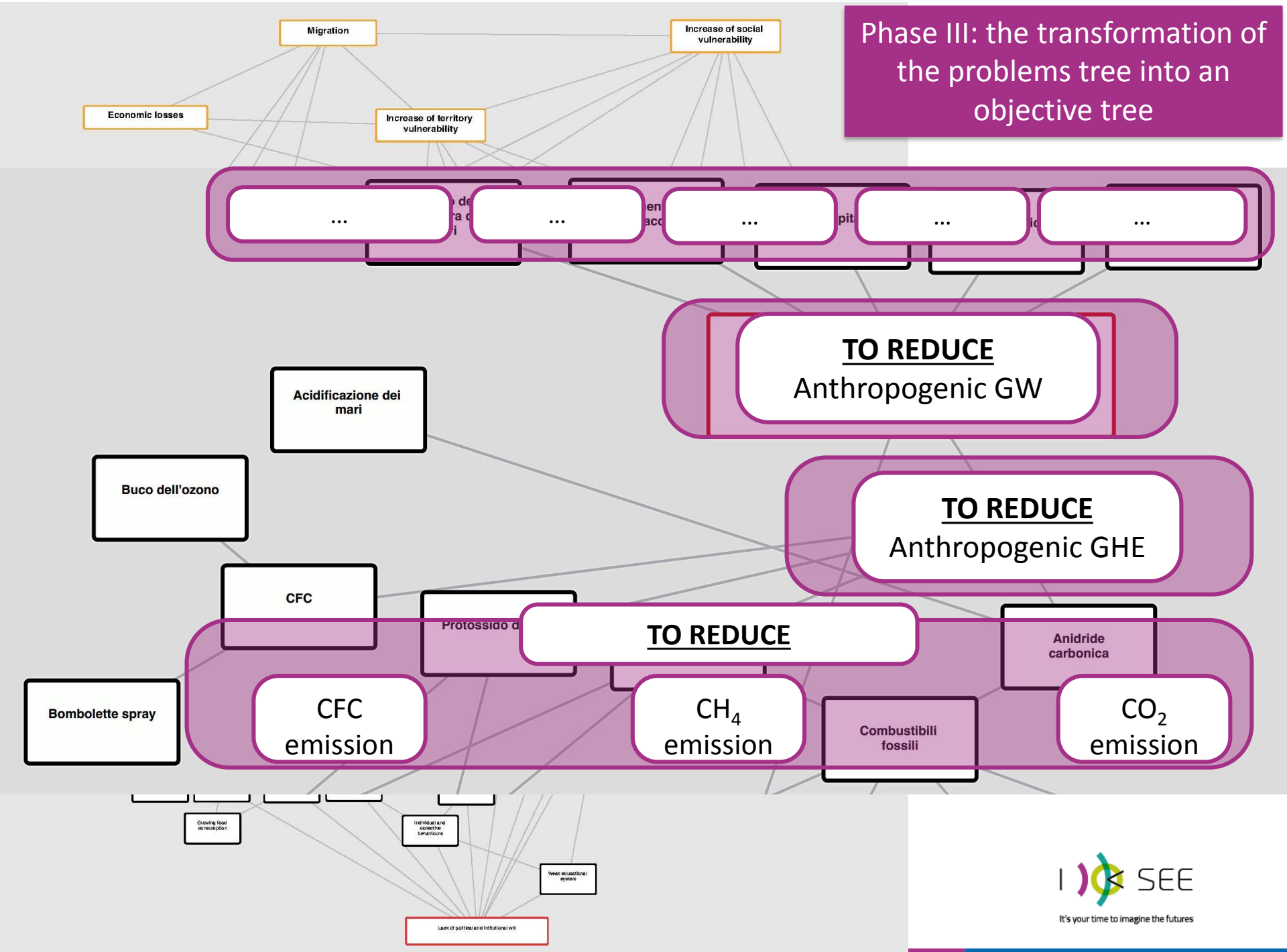
Phase III: the transformation of the problems tree into an objective tree



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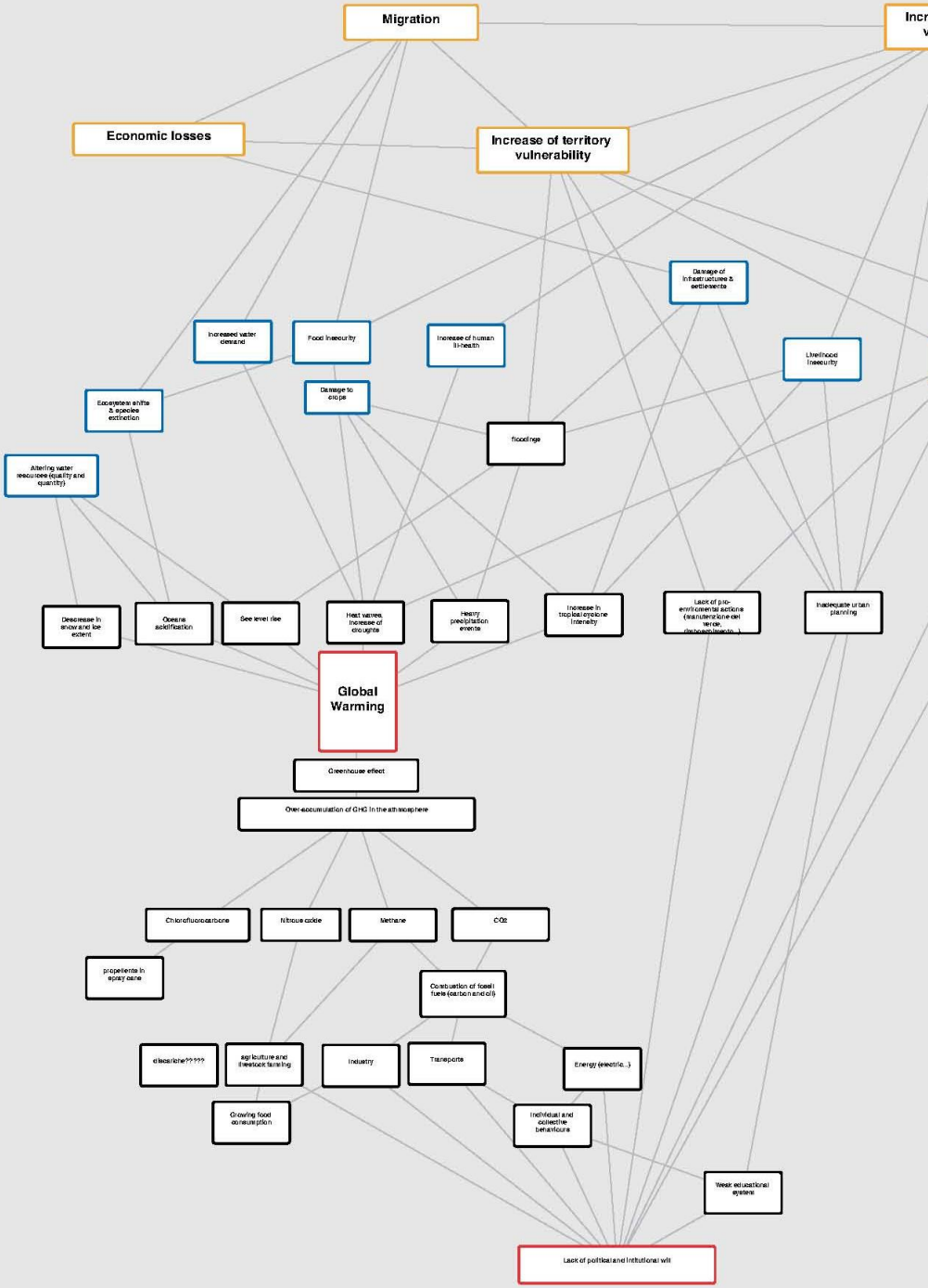
Phase IV: clusterization



Communication and awareness raising

Education

Research and technological innovation

Policy

IDEA SEE

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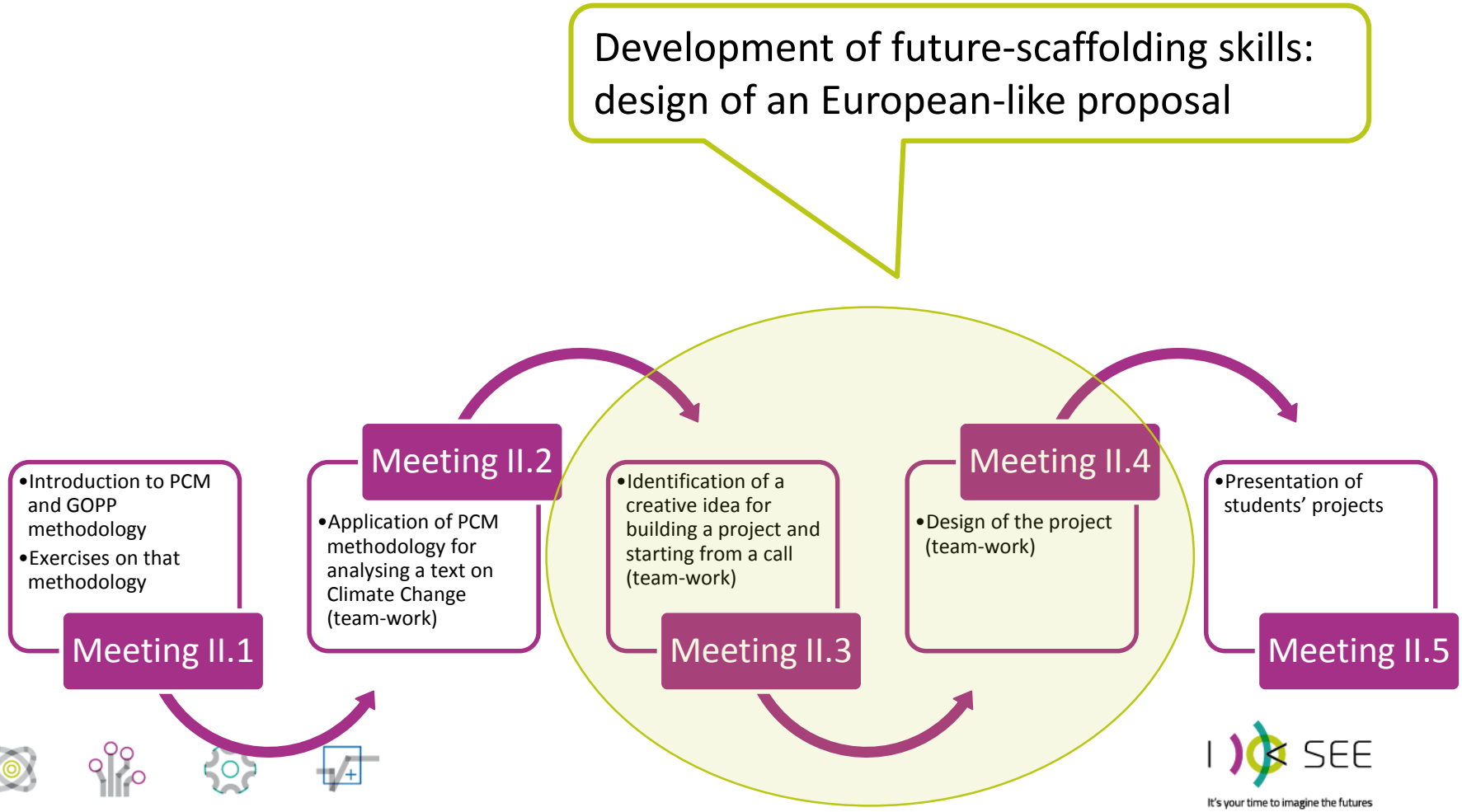
The “module”


Development of future-scaffolding skills: design of an European-like proposal
Meeting II.1
•Introduction to PCM and GOPP methodology
•Exercises on that methodology
Meeting II.2
•Application of PCM methodology for analysing a text on Climate Change (team-work)
Meeting II.3
•Identification of a creative idea for building a project and starting from a call (team-work)
Meeting II.4
•Design of the project (team-work)
Meeting II.5
•Presentation of students’ projects
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CALL: Rimini, the ideal future city in which living

The project will help to achieve at least three general objectives, among the following:

1. Reducing emissions by one or more of the major players in the business world (industry, agriculture, energy, tourism, fishing ...) influencing the conduct;
2. Reducing emissions from individual and collective behaviours, by making citizens understand the effects of their energy and food consumption habits on the problem of rising greenhouse gases;
3. Promoting and/or encourage the use of alternative energy and the development of environmentally friendly technologies;
4. Imagining innovative forms of urban planning (*smart cities*) with the help of ICT tools (*information and communication technology*) in order to ensure a sustainable development and a better quality of life (housing security, transport, green areas, etc.);
5. Promoting active citizenship actions in areas at high risk of marginalization on climate change issues in order to reduce social vulnerability;
6. Promoting information, communication and/or education strategies aimed at encouraging a cultural change related to climate change and problematize the science-culture-society relationship;
7. Identifying forms of exploitation of the historical, cultural, environmental and social heritage in order to promote a "responsible tourism" and, with this, to encourage cultural change processes aimed at reducing social and territorial vulnerability;
8. Influencing *policy makers* to promote policies that encourage mitigation and/or adaptation in the economic and productive, scientific and social world;
9. Promoting and supporting scientific research on climate change and influencing the world of scientific research in order to promote scientific communication and dissemination of high cultural profile and high social, political and economic impact.

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 … A1_n_1 …	
OB2 SO 2.1 … SO2.n	 A 2.1.1 A 2.1.2 … A2_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.

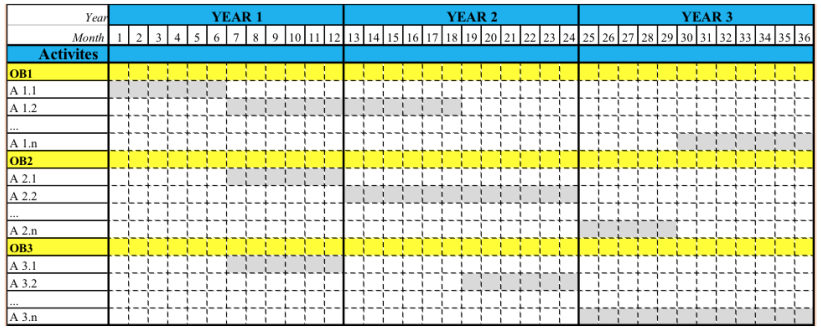

Figure 1 – prototype of a filled in GANTT CHART

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.

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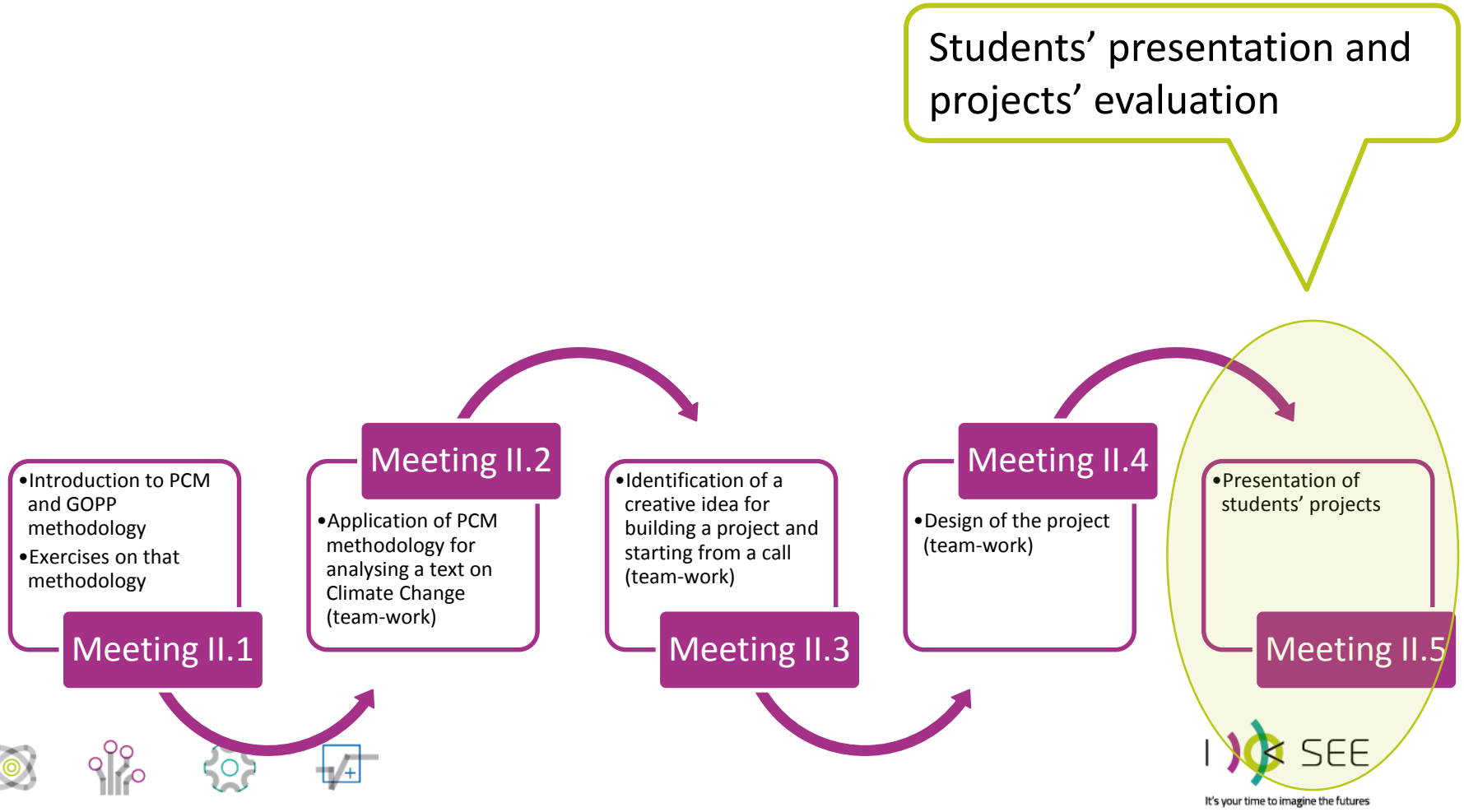
The “module”


Students’ presentation and projects’ evaluation
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•Introduction to PCM and GOPP methodology
•Exercises on that methodology
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Meeting II.5
•Presentation of students’ projects
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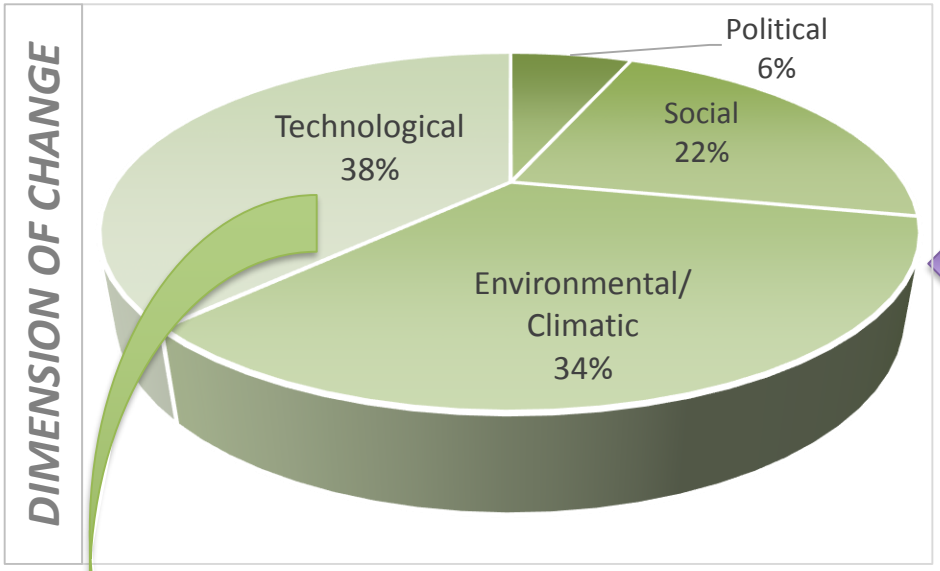
Data collection

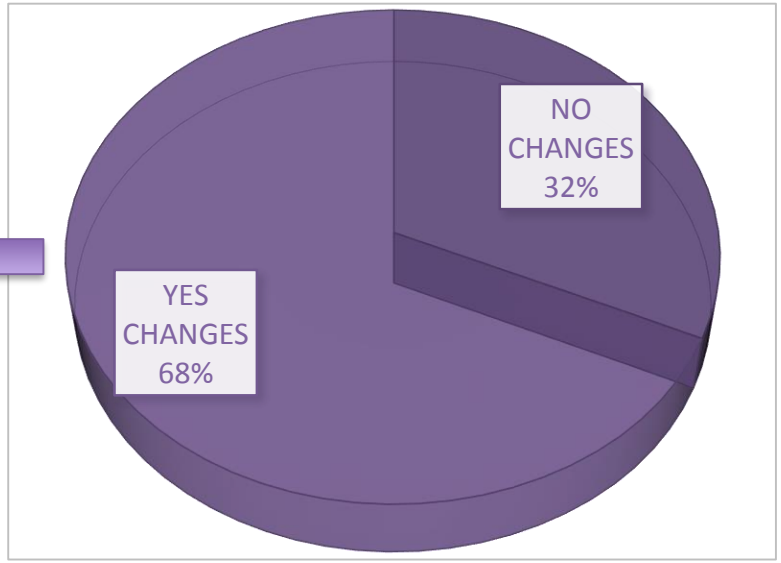
MAIN DATA SOURCES	MOMENT OF SUBMISSION			CHECKED ISSUE/DIMENSION		
	B	**D**	**E**	**CC**	**Imaginary**	**Creativity**
Written essay (about future in 2030)	X	X		X	X	X
Projects made by group of students (5)		X	X			X
Audio-recorded of groups' work		X				X
Audio and video recorded of the meetings		X				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

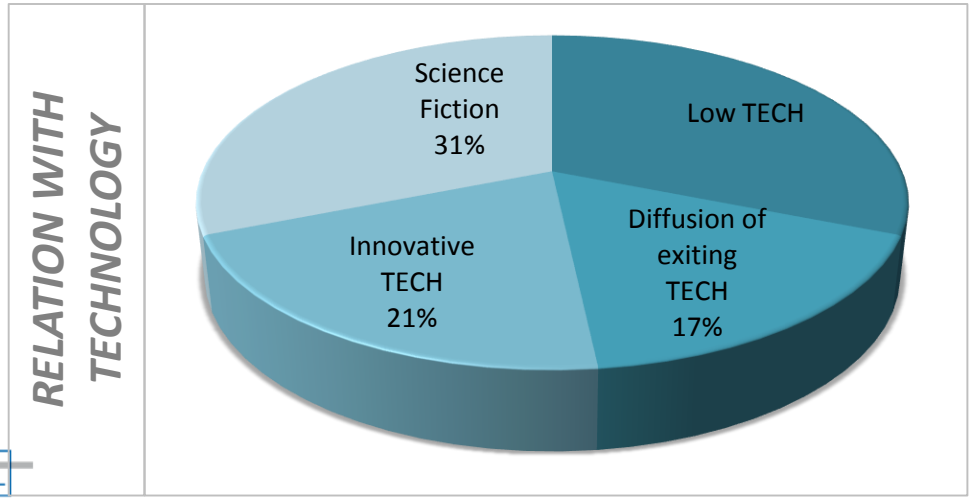
Legend of the table: ***B:*** *beginning of the path;* ***D:*** *during the path;* ***E:*** *at the end of the path*

Students' imagine of *future* - BEFORE

... relation with changes







… attitude toward future and climate change

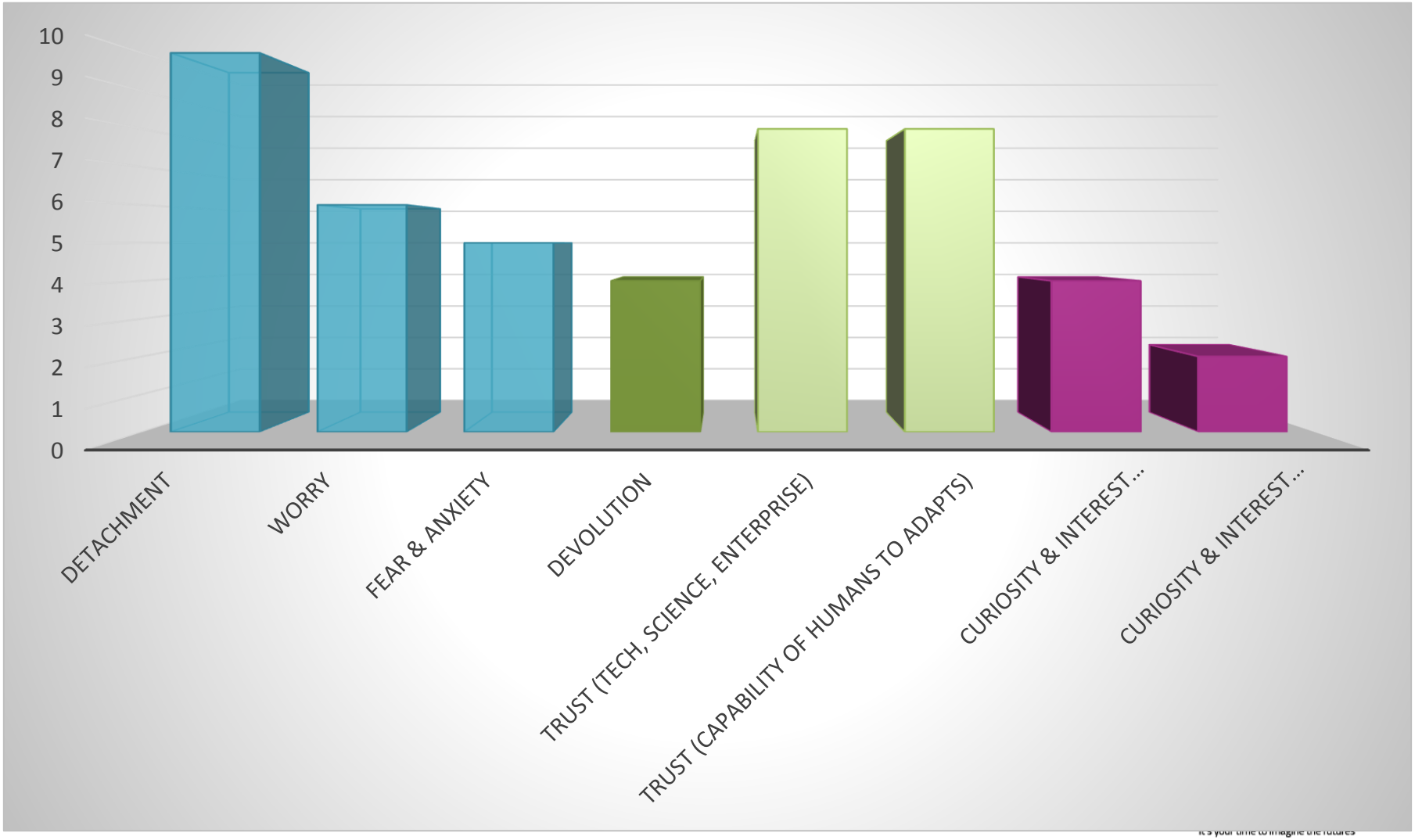


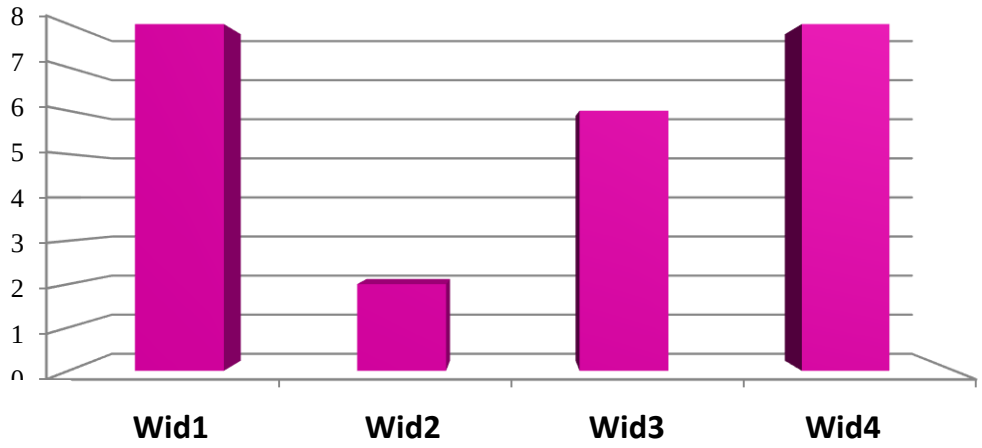
Image of *future* - AFTER

Emerging of a *scaffolding* that allowed

the view become clearer and wider

and the future closer

Scaffolding : WIDENING & APPROACHING



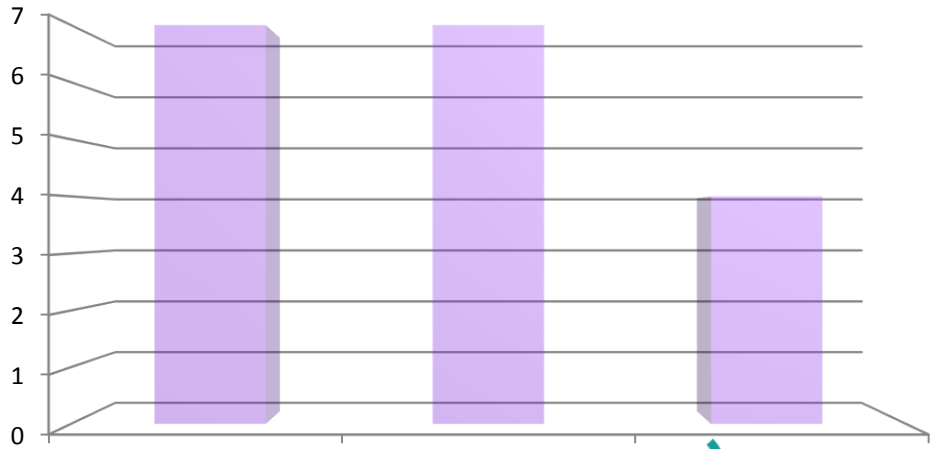
Wid1: knowledge of the topic;

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.



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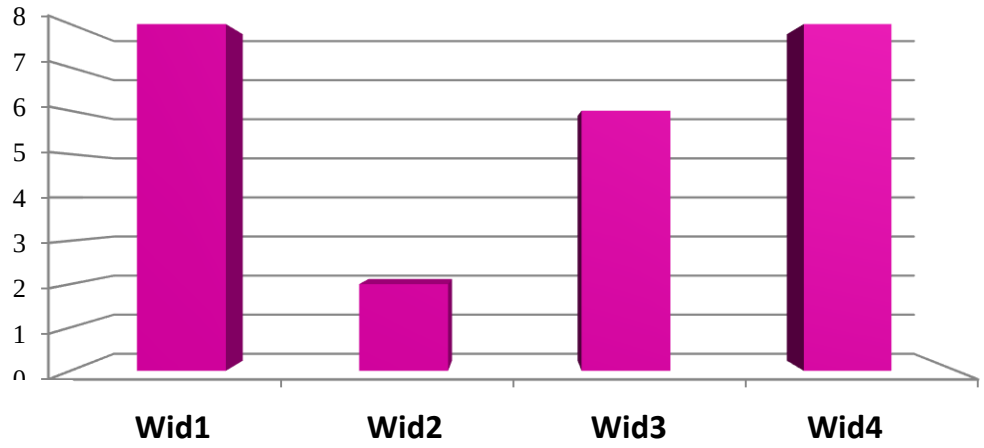

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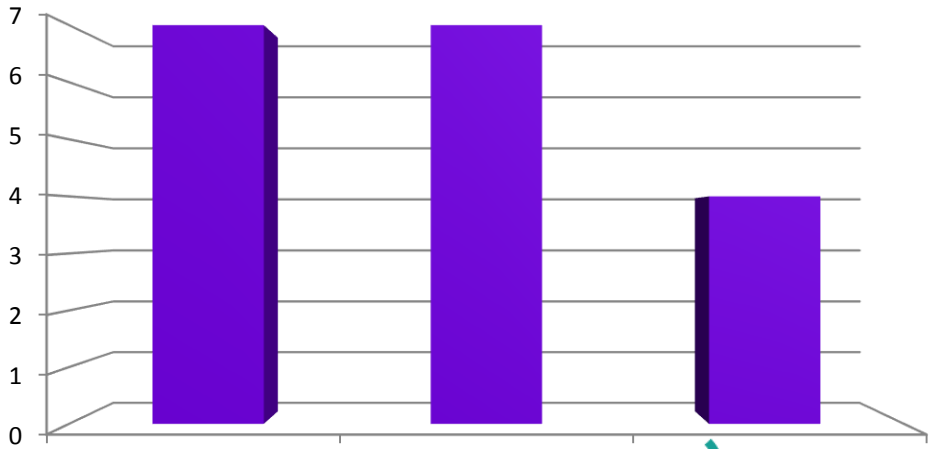

«The project has helped us **to think, to do something in relation to something else** [...] what I learned about **to move from problems to goals** struck me a lot, it also "woke me up", in the sense that many times we perhaps see all the problems and we do not see even a positive thing, with this project we have seen that and **how we can act** and otherwise **things are feasible**, we didn't that talk about abstract things. [...] If we are too much focused on one thing we can not see it in a global [...] instead **we must always have a vision both global and transversal, and then of course, when needed, we must able to go in the detail, but always remembering the context** in which you are.» (Elena)

«For me, **the activities have especially opened my mind and opened many ways more than I had before**. At the beginning, the activities have demoralized me so much because I thought, of course, to not be able to get there, however, I thought to not have a mind that could look ahead to what I can see now, better to what I could not see before, **rather through the project I am really able to get to the point where I thought that my mind does not arrive**. [...] The project changed my way of thinking, not only for me also for the others..» (Sara)

Results

The main result concerns the change in the perception of future that students' discourse reveals: ***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***.

Results – crucial steps

- Analysis of a complex problem and its transformation in a problem tree

From an unmanageable problem to a problem cognitively manageable

- Transformation of the the problem tree into an objective tree

From a problem to a challenge

- Research of the creative idea for the project

The exploration and the challenge of their potentiality

The I SEE Project

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- The goal within the project: drawing upon this positive experience to design further activities (and teaching modules) to develop future-scaffolding skills
  - **Future-scaffolding transversal skills**
  - Future-scaffolding scientific-hard skills

The I SEE Project

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- The goal within the project: drawing upon this positive experience to design further activities (and teaching modules) to develop future-scaffolding skills
  - Future-scaffolding transversal skills
  - **Future-scaffolding scientific-hard skills**

PLS

February-March 2017 –

(Presentation Eleonora Barelli)

I SEE Summer School

5th-9th June 2017

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Selection of references

Benasayag M., Schmit G., (2004) *L'epoca delle passion tristi*, Milano, Feltrinelli.

Denzin N. K., Lincoln Y. S. (2005). *Handbook of qualitative research.* Thousand Oaks (California): Sage.

Eurobarometer, 2015 *Public opinion on future innovations, science and technology, National report Italy*, Eurobarometer Qualitative Study, Giugno 2015

European Commission, (2004). *Europe needs more scientists: report by the high level group on increasing human resources for Science and Technology.* Brussels, European Commission.

European Commission, (2015). *Science education for responsible citizenship*, Brussels, European Commission.

Horizon 2020: http://educationduepuntozero.it/speciali/pdf/speciale_agosto2013.pdf

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0811:FIN:en:PDF

IPCC (2014). Climate change: Synthesis Report.

Levrini, O., Fantini, P., Pecori, B., Tasquier, G., & Levin, M. (2014a). Defining and operationalizing 'appropriation' for science learning. *Journal of the Learning Sciences*. DOI:10.1080/10508406.2014.928215

Manuale CE su PCM https://ec.europa.eu/europeaid/sites/devco/files/methodology-aid-delivery-methods-project-cycle-management-200403_en_2.pdf

Rosa H. (2013). *Beschleunigung und Entfremdung - Entwurf einer kritischen Theorie spätmoderner Zeitlichkeit, Suhrkamp (*Eng. Trans: *Acceleration and Alienation - Towards a Critical Theory of Late-Modern Temporality*, 2015).

Tasquier, G. (2015). Leading secondary school students to face the disciplinary, epistemological and societal challenges of climate change: design and analysis of multi-dimensional teaching/learning experiences. Phd Thesis.

The Economist Intelligence Unit (2014), *Closing the skills gap: companies and colleges collaborating for change*.