PARRISE
Promoting Attainment of Responsible Research & Innovation in Science Education

Socio-scientific inquiry-based learning

A pedagogy to promote Education for Environmental Citizenship

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Education for Environmental Citizenship (EEC)

The type of education which cultivates a coherent and adequate body of:

- **knowledge** as well as
- the necessary **skills**, **values**, **attitudes** and **competences**

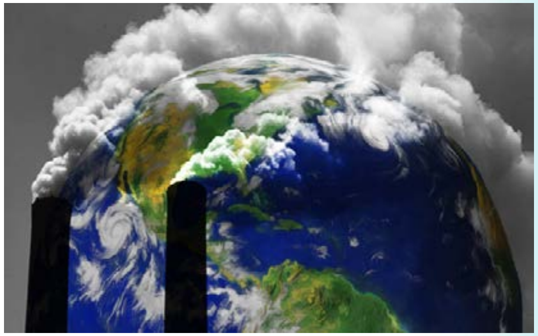
in order to be able to act and participate in society as an **agent of change** in:

- the **private** and **public sphere**,
- on a **local**, **national** and **global scale**,
- through **individual** and **collective actions**,

- in the direction of **solving** contemporary **environmental problems**,
- **preventing** the creation of new environmental problems,
- in **achieving sustainability** as well as **developing a healthy relationship with nature**

→ EMPOWER CITIZENS in: informed decision-making & taking action

Essential requirements for informed decision-making



next to

- Scientific knowledge,

- Self-knowledge
- Societal knowledge

should inform the decision-making process.

Essential requirements for informed decision-making

- Scientific knowledge:
  - e.g. subject knowledge, NoS
- Self-knowledge
  - e.g. being aware of your values, beliefs, and assumptions
- Societal knowledge
  - e.g. knowledge about the motives and strategies of influential stakeholders, social values, economical interests

Fostering these aspects of **democratic citizenship** :

- is an important aim of science education in many countries
- contributes to critical and **responsible partici**pation in society (European Commission, 2015).

→ EC emphasised the importance of RRI over the last 15 years

EC (2015) Science Education for Responsible Citizenship. Brussels, European Union.
http://ec.europa.eu/research/swafs/pdf/pub_science_education/KI-NA-26-893-EN-N.pdf

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RRI: Responsible Research & Innovation

RRI is about - working *with* and *for* people – to develop products that are:

- Socially desirable
- Sustainable
- Ethically acceptable (Owen *et al*., 2009)

European level importance of RRI in science education emphasised (EU, 2012)

Operationalising RRI in science education

Socio-scientific inquiry-based learning (SSIBL)*

Pedagogy that connects the study of:

- socio-scientific issues (SSI) with
- inquiry-based learning (IBL) and
- citizenship education (CE)

within the umbrella of responsible research and innovation (RRI)

*Levinson, R., Knippels, M.C., van Dam, F., Kyza, E., Christodoulou, A. ...et al. (2017) *Science and Society in Education.* Socio-Scientific Inquiry-Based Learning:connecting formal and informal science education.
https://www.parrise.eu/booklets/; www.parrise.eu;

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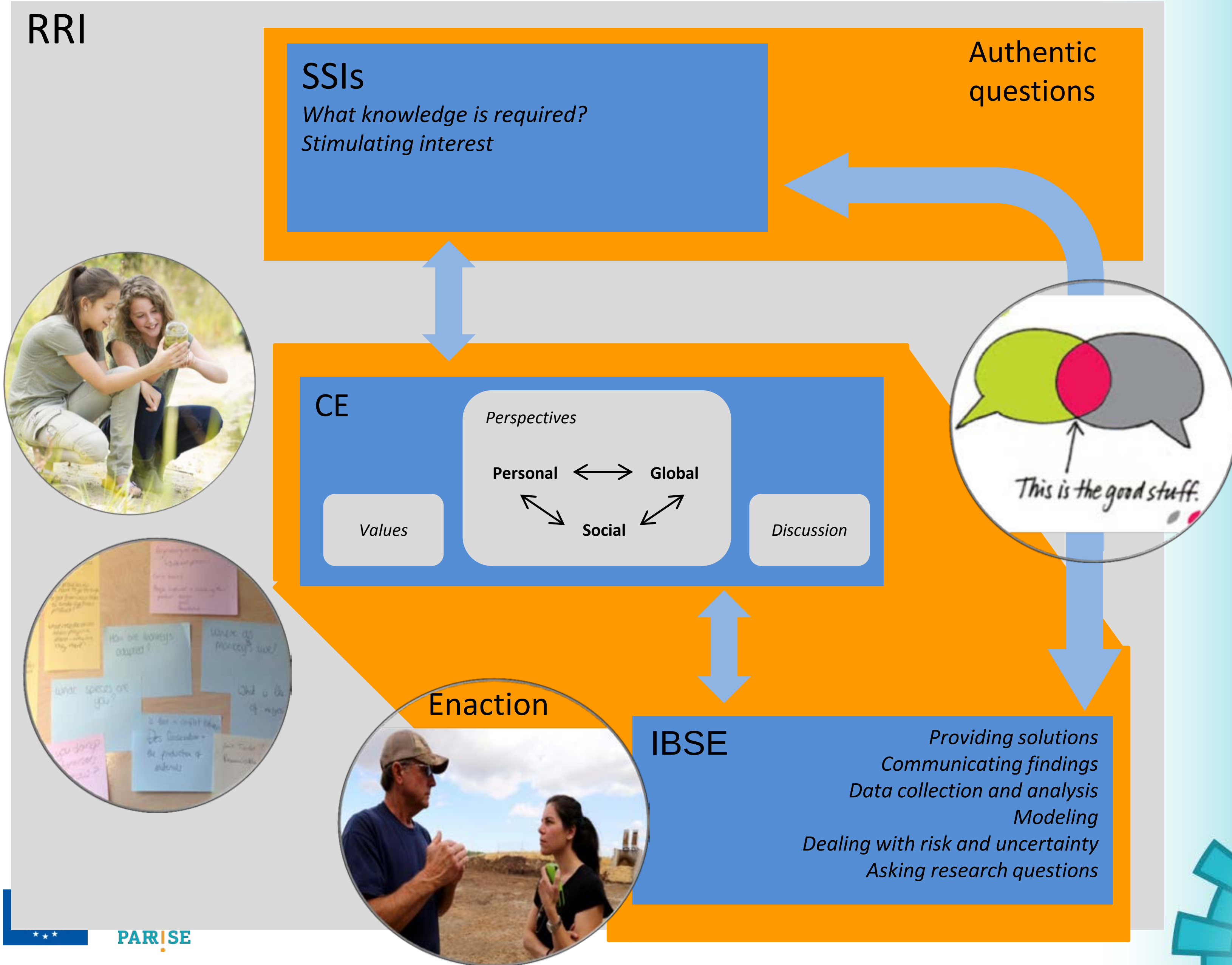
SSIBL (Socio-Scientific Inquiry based learning)

RRI

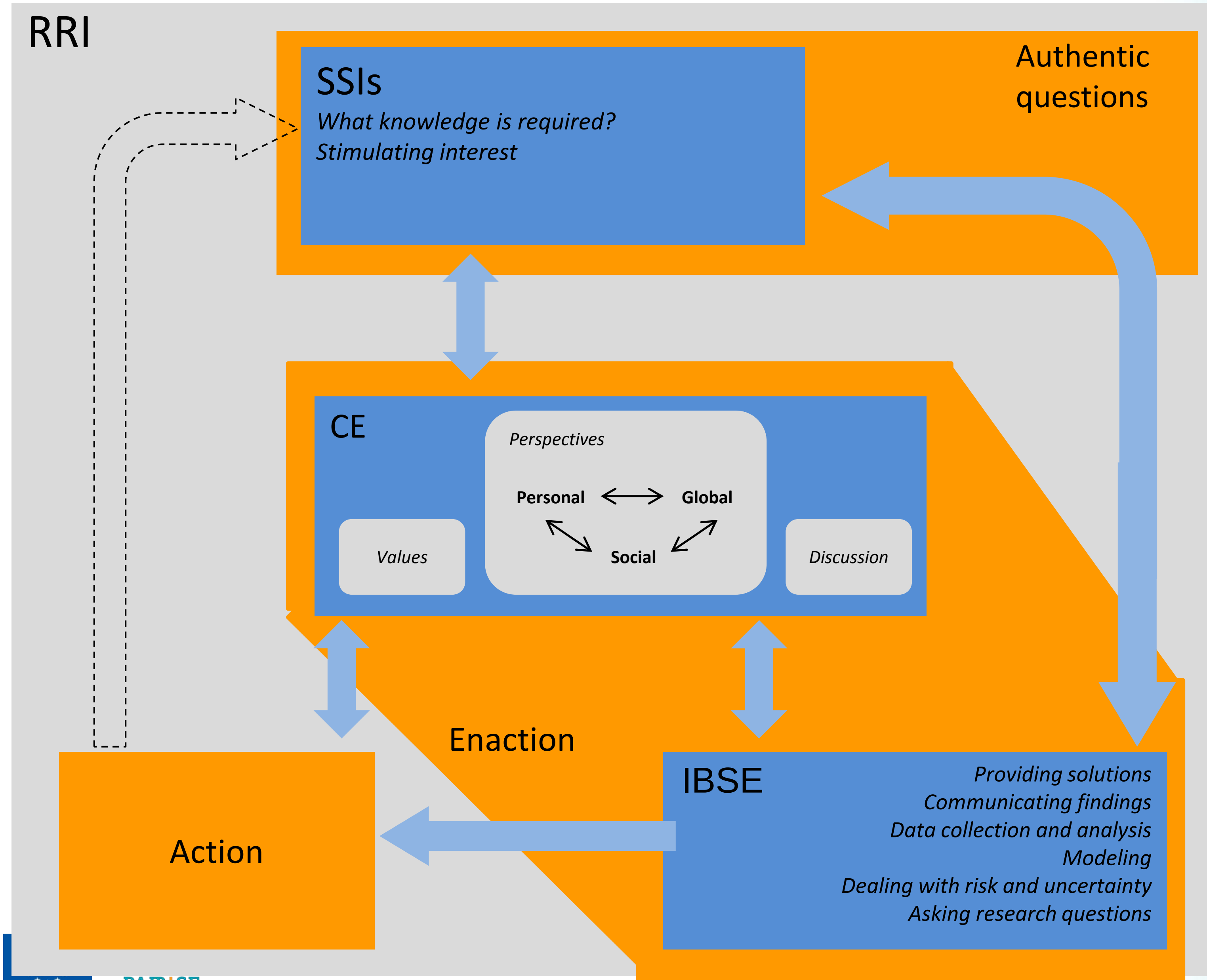
SSIs

Authentic questions

SSIBL (socio-scientific inquiry-based learning)



SSIBL (socio-scientific inquiry-based learning)



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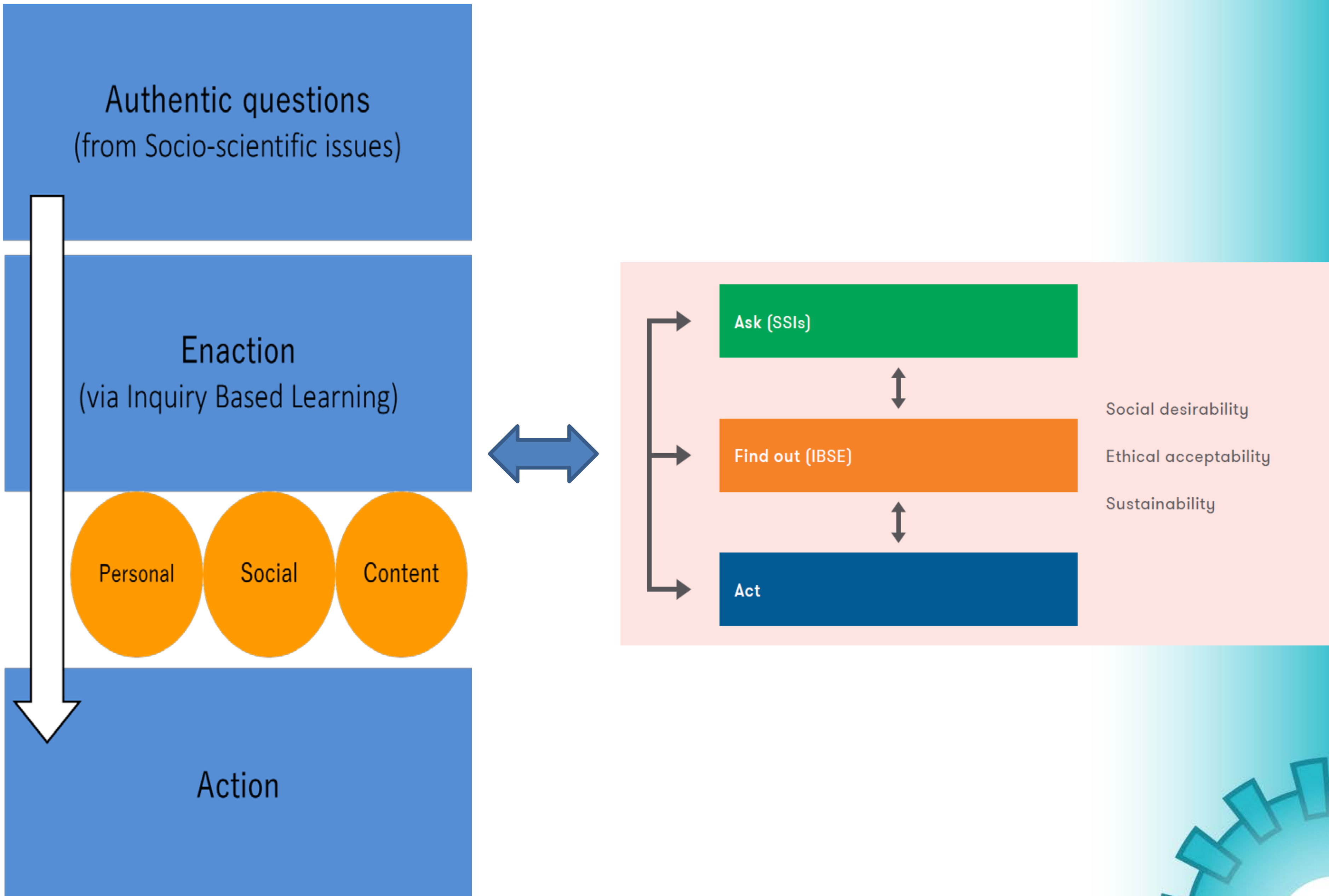
SSIBL approach



Educational phasing in lesson(module)*

1. **Introduction** of dilemma: connect to student's daily life, interest
2. **Initial opinion-forming** (individually or in small groups)
3. Raise questions: '**need to know**' (e.g. content related, social, and/or personal questions)
4. **Inquiry:** students answering the raised questions through social, personal and scientific inquiry
5. **Dialogue**: value clarification & communication
6. **Decision making**: formulate solutions which help to enact change
7. **Reflection**: on student's opinion-forming process (metacognition)

* Knippels, M.C. & van Harskamp, M. (2018) An educational sequence for implementing socio-scientific inquiry-based learning, *School Science Review*. (In press).

* Knippels, M.C., & de Bakker, E. (2016), Didactief, 12-13

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What are Socio-scientific Issues (SSIs)?

- Problems which arise in our society and have a scientific and/or a technological component.
- Are issues or problems because there is no consensus on how such problems might best be solved ('wicked problems')
- Therefore they have inherent moral and ethical components
- Involve opinion-forming and choice-making both at the personal and societal level

(Levinson, 2006; Sadler, 2011; Ratcliffe and Grace, 2003).

- Levinson, R. (2006). Towards a theoretical framework for teaching controversial socio-scientific issues. *International Journal of Science Education, 28*(10), 1201-1224.
- Ratcliffe, M. & Grace, M. (2003) *Science Education for Citizenship. Teaching Socio-Scientific Issues.* Maidenhead/ Philadelphia: Open University Press.
- Sadler, T.D. (2011). *Socio-scientific Issues in the Classroom: Teaching, Learning and Research*. Springer.

Activity 1 – Analysing controversies and asking questions

Write down on the worksheet [handout]:

- What is the case about, what is the controversy?
- Which stakeholders are involved, which societal values are associated with this?
- What could you do with it in your lesson?
- What content knowledge is relevant?
- What questions does the issue raise that your students could investigate?

Discuss a) the bioplastics issue, and b) an issue of your choice

USING THE HAND-OUT

Questions	Case A	Case B
What is the case about, what is the controversy?		
Which stakeholders are involved, What are their interests, What are their arguments?		
Which social values are involved?		
What science content knowledge is relevant?		
Which questions does it raise?		

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EXAMPLE: ETHICAL MATRIX (MEPHAM)
A TOOL

Respect for: / Stakeholders	Wellbeing	Autonomy	Justice
…….			

Mepham, M. (2000). A Framework for the Ethical Analysis of Novel Foods: The Ethical Matrix. *Journal of Agricultural and Environmental Ethics*, *12*(2), 165–176.

Example 'Oostvaardersplassen' (nature reserve) issue: Overpopulation big grazers, animals are threatened by starvation; intervene or not?

Respect for: / Stakeholders:	Wellbeing	Autonomy	Fairness
Visitors to the park	Pleasant visit to the national park	Able to enjoy the national park in their own way	Assure affordability to visit the national park
Animals	Enough food to live	Are able to migrate to areas with enough food	Sustainability of population, intrinsic value
Forestry Service	Feel successful in and capable of performing their job in the available time	Able to perform their job in the way they prefer it	Ensure natural ecosystem equilibrium
NGOs	Animal rights laws respected	Able to act on their values and beliefs and fulfil their professional mission	Duty of care

Climate change:
It's not really happening, is it?

More than 97% of scientists working in the disciplines contributing to studies of our climate, accept that climate change is almost certainly being caused by human activities.

- **What do *you* think?**

http://tiki.oneworld.net/global_warming/climate7.html

Is it our fault that our planet is getting warmer?

In groups of 4:

1. Sort the evidence into four categories:
   - for/against human-made climate change
   - For/against naturally occurring climate change

2. Consider the nature of the evidence: *can you make a decision about who is causing global warming*?

   - *Does this affect your decision on whether to take action?*

Climate change is…	Evidence to support…	Evidence against…
human-made (anthropogenic)		
naturally happening		

Table 1 Certainties and uncertainties in climate change science

More certain ⟵		⟶ Less certain
• The global surface temperature has increased 0.8 °C since measurements began in 1850. • Each decade since 1970 has been warmer than the previous. • In the past 30 years, there has been an overall decline in sea ice in the Arctic Ocean. • Global average CO_2 concentrations have increased from 280 ppm in 1850 to 398 ppm today. • The concentration of methane in the atmosphere has doubled in the last 150 years. • Changes in the composition of the atmosphere have caused an enhanced greenhouse effect. • Ice cores show a correlation between CO_2 concentration and global temperature.	• Even if we stopped emitting CO_2 today, the CO_2 currently in the atmosphere would stay for a very long time. • There are a large number of other variables (both natural and human-made) involved in the climate of which we do not know the effects (e.g. volcanic eruptions, water vapour). • Climate models have difficulty in simulating the overall effects of numerous variables. • Current temperature change can only be matched by models if both natural and human-caused variables are included. • Projection of future climate change depends on a number of unknown factors such as mitigation efforts to reduce CO_2. • Projected temperature increases using several CO_2 emission scenarios is 1.5–4.8 °C by 2100. • Ocean temperatures will continue to rise and sea levels will continue to rise even if emissions were stopped today.	• Some aspects of the climate are not as well understood and are difficult to model (e.g. clouds). • The future uptake of CO_2 by the land (vegetation and soil) and the ocean is poorly understood. • The effects of land ice melting (Greenland and West Antarctica) are uncertain. • The circulation changes in the North Atlantic Ocean are not well predicted. • Models have difficulty modelling regional effects (current models are at the continental scale).

Adapted from Royal Society (2010) and IPCC (2013).

Busch, K. C., & Osborne, J. (2014). Effective strategies for talking about climate change in the classroom. *School Science Review*, *96*(354), 25-32.

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Table 2 Challenges and suggestions for talking about climate change

Challenge	Suggestion
1. Scepticism	Listen first
2. Complexity	Include the social dimension
3. Uncertainty	Use language carefully
4. Scale	Make it personally relevant to students
5. Emotion	Balance emotion with logic

Busch, K. C., & Osborne, J. (2014). Effective strategies for talking about climate change in the classroom. *School Science Review*, *96*(354), 25-32.

Framing the issue for productive discussions and to inspire ACTION:

- Focus on **human & environmental** impact: 'Climate change is dangerous for *humans*, especially those living in low-lying coastal areas'; 'Climate change is dangerous for birds and animals, especially those already in danger of losing their habitats (e.g. polar bears).

- Focus on the **present**: 'Climate change is affecting us *now,* so we need to take action for *us*, and *future generations*'

- Focus on **space – local surroundings**: 'how will climate change affect our immediate environment and surroundings?'

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Busch, K. C. (2016). Polar bears or people? Exploring ways in which teachers frame climate change in the classroom. *International Journal of Science Education, Part B*, *6*(2), 137-165.

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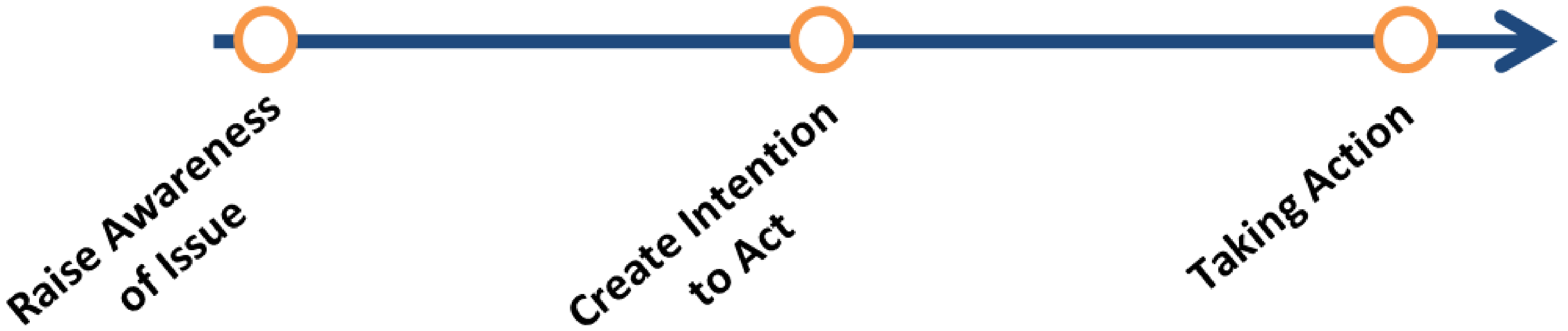
Taking Action



Taking action (e.g. proposing or implementing solutions to a problem)

How?

PARRISE booklet

Science and Society in Education

https://www.parrise.eu/booklets/

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Promoting **A**ttainment of **R**esponsible **R**esearch and **I**nnovation in **S**cience **E**ducation

- FP7-SCIENCE-IN-SOCIETY European project
- Coordination and Support action: **SUPPORTING** (CSA-SA)

- **Work programme:** *Raising youth awareness to **Responsible Research and Innovation** through Inquiry Based Science Education*

- 18 partners, 11 countries
- 4 years (1-1-2014 until 31-12-2017)

- **Science and Society in Education**

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