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Symposium Responsible Research and Innovation: the role of science education

Jan Apotheker

Four speakers

- Jan Apotheker, Groningen
  - Responsible Research and Innovation: the project Irresistible
- Miika de Vocht, Helsinki
  - Diagnosing teachers' concerns and interests about teaching RRI
- Pedro Reis, Lisbon
  - The potential of student-designed exhibits about RRI: the teachers perspective
- Ron Blonder, Weizmann
  - The rationale of RRI
- Discussiant Sherman Rosenfeld, Weizmann

The project Irresistible

- FP7 project: Raising Youth awareness to Responsibe Research and Innovation through Inquiry based Education
  - Increase content knowledge about research by bringing topics of cutting edge research into the program
  - Fostering a discussion among students about RRI issues about these topics

Irresistible partners

- University of Groningen
- Weizmann Institute of Science
- IPN
- Deutsches Museum
- Bogazici University
- Universidade de Lisboa
- University of Palermo
- University of Jyväskylä
- University of Bologna
- University of Crete
- Jagiellonian University
- Valahia University Targoviste
- University of Helsinki
- Eugenides Foundation (Idryma Evgenidou)

Responsible Research and Innovation

Six main keys

- Engagement
- Gender equality
- Science education
- Ethics
- Open Access
- Governance

Aspects of RRI

Aspects of RRI mentioned by Sutcliffe
The deliberate focus of research and the products of innovation to achieve a social or environmental benefit.
The consistent, ongoing involvement of society, from beginning to end of the innovation process,
Involvement of the public & non-governmental groups, who themselves are mindful of the public benefit.
Assessing and effectively prioritizing social, ethical and environmental impacts, risks and opportunities, both now and in the future, alongside the technical and commercial.
Where oversight mechanisms are better able to anticipate and manage problems and opportunities and which are also able to adapt and respond quickly to changing knowledge and circumstances.
Where openness and transparency are an integral component of the research and innovation process.

In the modules:

Responsible Research and Innovation (RRI)

'Society becomes more involved'

Many people think of science and innovation as activities that are carried out by smart people, far away at universities and companies. Sometimes, it seems as if scientific research does not properly match with what is important to society and that 'ordinary people' have no influence on it. The European Union has created the term 'Responsible Research and Innovation' (RRI) to achieve that people can more easily converse with scientists and the business world. In this way, society becomes more involved in scientific research and innovation.

This is what Responsible Research and Innovation is about: people working on scientific discoveries and innovations, must do so in a responsible way.

RRI has six components:

1. Engagement: researchers, industry, policy makers, and citizens have to collaborate in the research and innovation process. In this way, social, economic, and ethical interests of all groups can be included to find a joint solution for societal problems.

The European Union, the United Nations, and other governmental institutions have identified a number of 'Grand Challenges' of modern day society that science could answer. These challenges are worldwide problems such as clean drinking water, proper food production, poverty, hunger, and climate change, as well as aspects that focus more on Western society, such as healthy aging, Internet safety, and sustainable transportation. Good education and reducing child mortality are also on these lists.

In the Netherlands, the government has established the 'Science Vision 2025' in November 2014. This vision states the challenges for Dutch society. These are: quality of life, circular economy, resilient society, building blocks of life, complexity: coping with unpredictability and big data. For society, it's important that exactly these problems are solved by means of scientific research and innovations, by engaged researchers.

2. Gender equality: men and women must be equally involved in research and innovation; the full potential of the population must be used. In 2011, over half of the people graduating from university in the Netherlands were women, but less than 15% of professors is female (Monitor Vrouwelijke Hoogleraren, 2012). People mainly think of men when talking about professors (do a Google Images search for 'scientist').

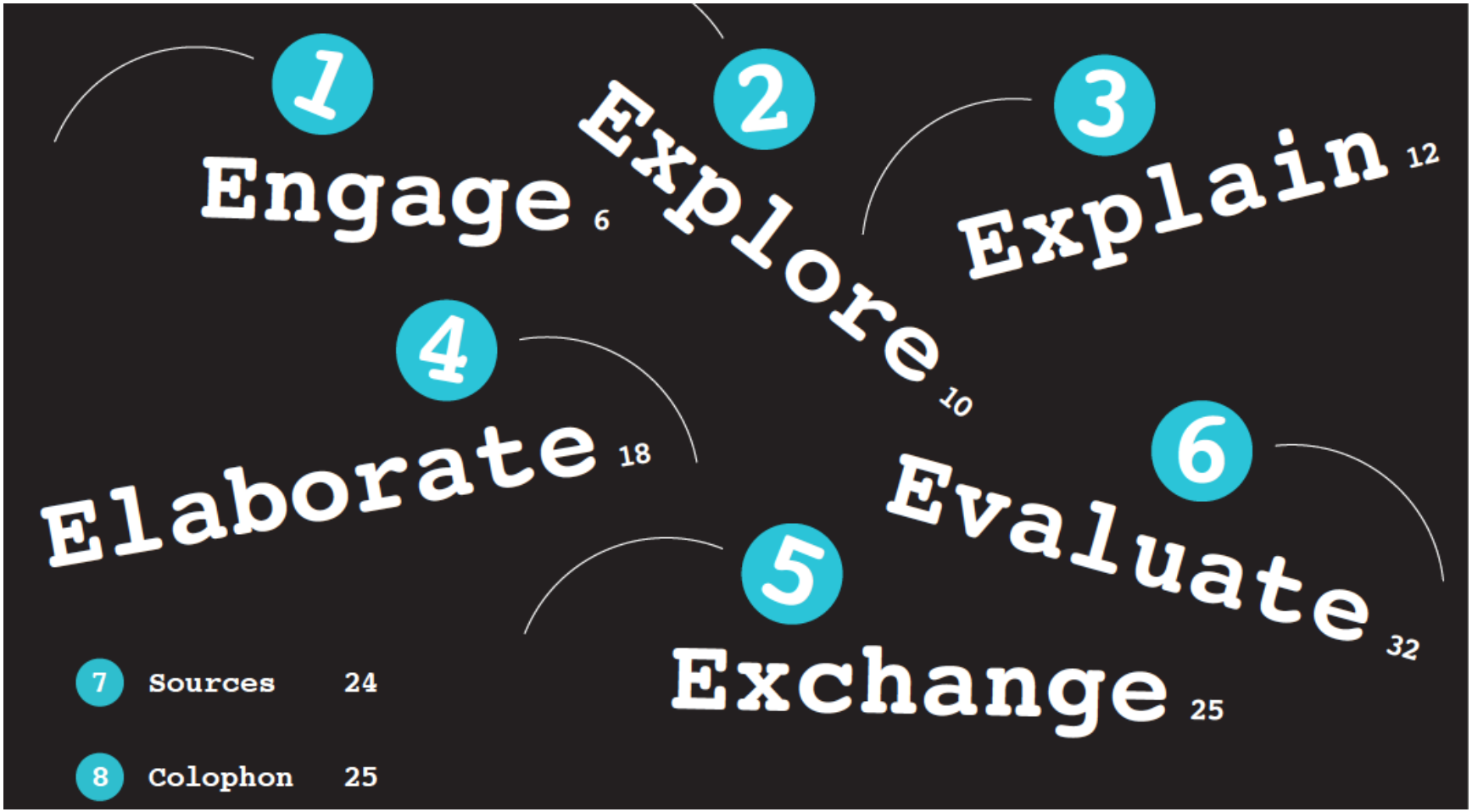
Community of Learners

- Combining
  - Research groups
  - School community
  - Science centers
- Working on
  - Central research theme
  - Focus on Responsible Research and Innovation

Science education

- Educational material
  - Formal learning
  - Informal learning
  - Science content
  - Societal issues

Frame work of the material



Engage

Secrets of Breast Milk

'Why don't babies just drink milk from the supermarket?'

Human beings are (also) mammals: human beings, apes, cats, dogs, cows, goats; they all belong to the class of Mammalia: mammals. The common characteristics of mammals is that they 'nurse' their offspring, that is, feed them by means of breast milk. All mammals produce milk after giving birth that has the ideal composition to help their offspring grow optimally. Goat's milk is made for goats, cow's milk is made for calves, and human milk has its own special composition that optimally help babies to develop

How long animals are nursed is dependent upon the kind of animal: cats do this approximately 8 to 12 weeks, a walrus two to three years. And this is different for human beings. Originally, mothers nursed their children for about five years, eventually mainly as additional nutrition. This is still the case in developing countries. In a modern country, such as the Netherlands, where women often start working again after giving birth, women don't breastfeed as long. The World Health Organization (WHO) advises mothers to completely breastfeed up to six months, and to continue breastfeeding until the age of two in addition to giving other food. Not a lot of mothers in the Netherlands do this. Breastfeeding a toddler of two is often considered to be strange and controversial (the cover of the magazine to the right created a lot of commotion). In the Netherlands, this doesn't happen often. Unfortunately it isn't measured, but estimations vary that only 2–5% of the mothers still breastfeed their toddler.

Breast milk: superfood?

If the WHO advises breastfeeding until age two so passionately, it must be really good. But why is that the case? Isn't milk just milk? And couldn't you just give your baby milk from a carton? The answer is no. Breast milk differs from regular milk in various ways. First, breast milk adapts to the needs of the child through time. Breast milk of three weeks after birth is different than after three months, especially attuned to what the baby needs at that particular

Experiment

With various experiments, you can determine the protein, fat, and carbohydrate level of various types of milk. Follow your teacher's instructions when you conduct these experiments.

Deliverables

- At least 10 well tested learning activities
- Awareness with RRI for
  - Researchers
  - Teachers
  - Students
  - Science centers

Titles of material 1

1 Portugal	Geo-engineering and ckimate control
	Evaluate earth health through polar regions
2 Finland	Atmosphere and Climate change
3 Turkey	Naon and health science
4 Poland	The catalytic properties of nanomaterials
5 Netherlands	Carbohydrates in breastmilk

Titles of material 2

6 Romania	Solar energy and specific nanomaterial
7 Italy (Bologna)	Nanotechnology for solar energy
	Nanotechnology for information by exploiting light/ matter interaction
Palermo	Energy sources
8 Israel	The RRI of Perovskite based photovoltaic Cells
9 Germany	Oceanography and climate change
	Bane of the Oceans
10 Greece	Nanoscience applications

Use of 6 E model

- Normally Engage, Explore very explicit
- Use of science center/ research center in Engage phase
- Other steps often less clear
- RRI often introduced in Elaborate
- Use of Role-play in three modules

Introduction of cutting edge research

- Photo voltaic cells
  - Graetzel cells
  - Perovskite cels
- Luminescent nanosensors
- Off shore wind energy
- Plastic waste in the oceans
- Geo-engineering
- Specific carbohydrates
- application of silver nano particles as bacteriostat
- Role of nanomaterials as catalyst

Introduction RRI

- In role play modules RRI is incorporated in role
- Elaborate and Exchange work very well for introduction of RRI
- Engagement, open access, ethics and governance are easiest to incorporate gender and science education are more problematic

Use of web 2 applications

- Website
- Dropbox
- Facebook

Formal learning/ informal learning

- In some cases nicely integrated with visit to science centers
- Good cooperation with exhibits made by students
- Fits well in 6E method

Some conclusions

- Fitting cutting edge research into secondary school curriculum is feasible
- Introduction of RRI issues is possible
- Exhibits play a positive role in focus on RRI
- Exchange of modules will be a challenge

Some examples

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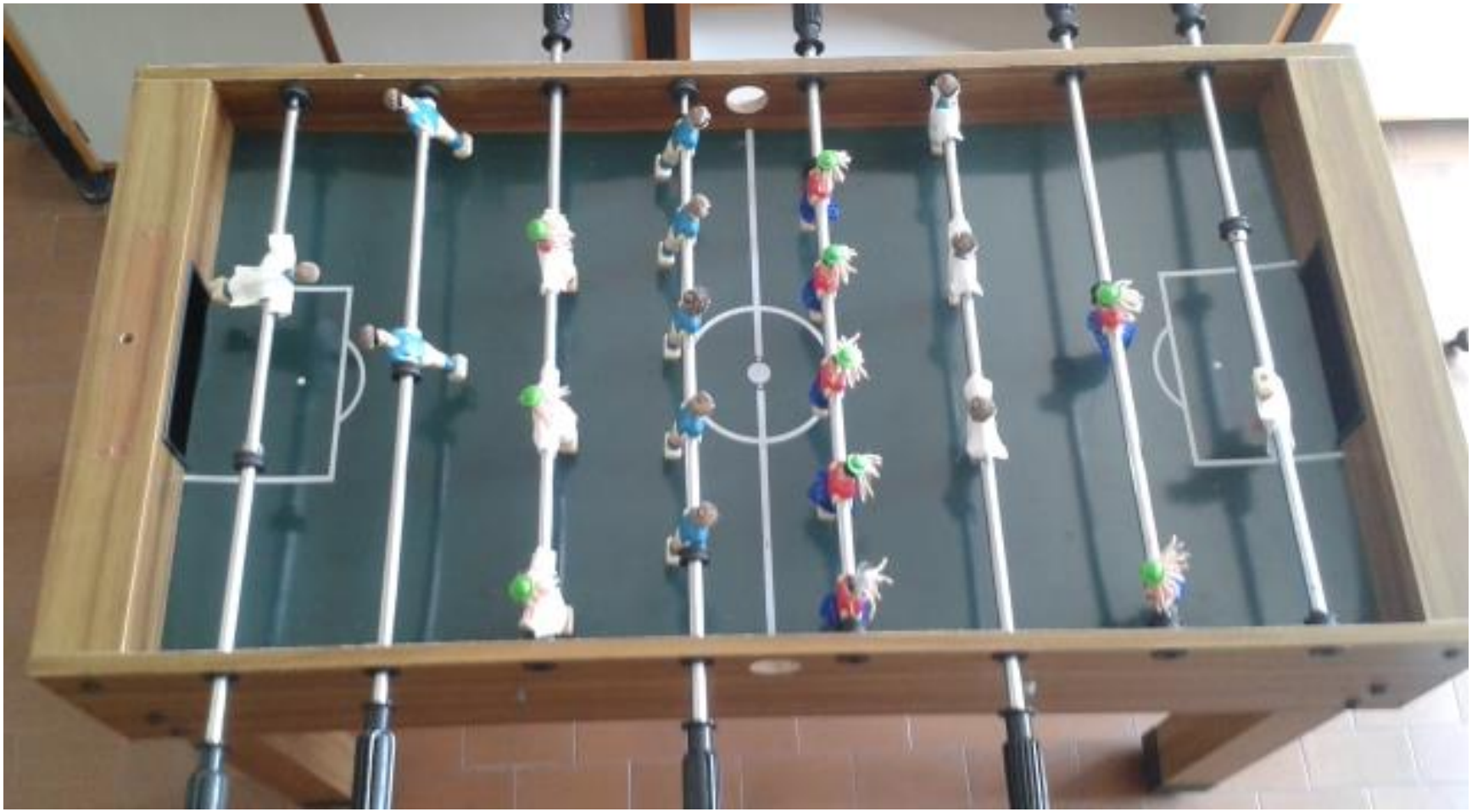
Football game



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ECOLOPOLY

Equo and Ecologic game

Debate

Student exhibitions

Greece

Netherlands

Netherlands

Carbohydrates in Mother's Milk: healthy ageing starts with *mammae*

A better health with smart carbohydrates

Jan Apotheker, Eva Teuling & teachers, Science LinX, University of Groningen, The Netherlands

Introduction, topics of the module

Why do babies drink breastmilk or baby formula, and not milk from the supermarket? What is the difference between cow's milk and mother's milk? And why is mother's milk the best choice for babies?

In this module, we answer these questions and try to explain why the WHO advices breastfeeding over bottle-feeding. We describe how the digestive system of babies differs from that of adults and show how the gut of a sterile baby is colonized by bacteria in the first days and months after birth. We explain how 'magic molecules' (*oligosacharides*) in mother's milk help to develop a healthy gut microbiome, and how the microbiome influences different aspects of health later in life. In addition, we talk about the biochemistry of milk, we show how baby formula is produced in the factory and how companies try to engingeer the 'magic molecules' in mothers milk. The conclusion is that process chemistry can't mimic mother nature, and this will be further emphasized by going over the

Module details:

- Suitable for upper level secondary school
- 12 lessons/ hours
- Combination of biology and chemistry classes

Six keys of Responsible Research and Innovation

1) Engagement: In the module it becomes clear that not only research and industry should lead the way in the development of new products, but that the opinion of others, like mothers and politicians, is very important too
2) Gender Equality: The production of baby formula helped in the emancipation of women, but breastfeeding is still better. Gender is a very important issue in this topic.
3) Science Education: Students learn about cutting-edge science on the microbiome and its applications in industry. In addition, they also learn about the ethics of the implications, both important aspects for their possible future role as scientsts
4) Open Access: Everybody should have acces to details about baby formula and mothers milk to make good decision on what to use, and why.
5) Ethics: In the elaborate-phase, we let the students debate about the production of milk for babies while human milk is better, and about the choices that mothers make

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- http://www.irresistible-project.eu/index.php/en/