Grant Agreement Number 612367

irresistible

Including Responsible Research and innovation in Cutting Edge Science and Inquiry-based Science Education to Improve Teacher's Ability of Bridging Learning Environments

D6.6 Practical Dissemination

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1. Executive Summary

The expected impact of the IRRESISTIBLE project is to spread the idea of enriched teacher education for the excellence of science education focusing on inquiry-based science education and responsible research and innovation in cutting-edge scientific research. Each partner is therefore required to disseminate the performed activities and the obtained outcomes across Europe using suitable communication methods.

Concerning the dissemination tools, the most important ones used by the project are:

- *IRRESISTIBLE Website:* The project website is the major tool of dissemination and is used at every stage of the project to provide information about the project;
- *Facebook pages:* Facebook pages at national level are created to spread the information about the project among younger users;
- *Information Platform (IP):* A multipurpose web-based platform, Information Platform (IP) has been designed and implemented to collect, monitor and exchange all the documents and materials concerning the educational activities provided by the project (see Deliverables 6.5);
- *Networks among teachers at national and international levels:* This tool aims at supporting the teachers' work and ensuring the spreading of educational best practices beyond the group of teachers and schools directly involved in the project;
- *Newsletter and blog:* Through the project newsletter and blog the performed activities are published and advertised (see Deliverables 6.10);
- *International and National Conferences:* Participation of the project partners in National and International Conferences in Teacher Training and Science Education is essential to inform teachers and researchers (both from the project and from other networks and projects), policymakers, and media representatives of the IRRESISTIBLE aims and activities;
- *National/Local Workshops and Seminars:* Participation in local workshops and seminar presentations to various stakeholders is also important to disseminate the goals, strategies, and the outcomes of the project;
- *Journal articles:* Submission of articles to distinguished science education journals, both at international and national level, is another tool essential to disseminate the project aims.

The purpose of Deliverable 6.6, Practical Dissemination, is to summarize the effort made by all the partners to disseminate the IRRESISTIBLE aims and activities focusing on:

- ✓ **participation in National and International Conferences**
- ✓ **participation in National or Local Workshops, National or other EU-project Meetings**
- ✓ **submission of articles to National and International Science Education Journals**
- ✓ **preparation of flyers to be distributed at conferences and meetings.**

The articles/presentations/flyers produced by each partner and detailed in the deliverable can be found at the following page of the Irresistible website: http://www.irresistible-project.eu/index.php/en/internal/internal-presentations. Some selected publications are open access at http://www.irresistible-project.eu/index.php/en/resources.

Examples of the activities carried out to disseminate the project are illustrated in the Appendix to this deliverable.

2. Partner activities to practically disseminate the project

The table reported below gives an overview of the partner involvement in disseminating the Irresistible aims and activities at the international, national and local levels since the beginning of the project. In the following sub-sections the activities of each partner are described in detail.

TYPES OF ACTIVITIES	COUNTRIES
A. NATIONAL CONFERENCE PRESENTATIONS (37)	Netherlands (5) Israel (4) Turkey (2) Portugal (2) Finland (3) Italy (1) Greece (4) Poland (14) Romania (2)
B. INTERNATIONAL CONFERENCE PRESENTATIONS (50)	Netherlands (4) Israel (2) Germany (1) Turkey (4) Portugal (2) Finland (5) Italy (4) Greece (7) Poland (5) Romania (16)
C. PUBLICATIONS (31)	Netherlands (3) Israel (2) Germany (3) Portugal (2) Finland (2) Italy (3) Greece (1) Poland (11) Romania (4)
D. WORKSHOPS (18)	Netherlands (1) Germany (2) Portugal (3) Italy (1) Poland (1) Romania (10)
E. NATIONAL AND OTHER EU PROJECT MEETINGS (11)	Israel (3) Portugal (1) Greece (3) Italy (2) Poland (2)
F. FLYERS	Netherlands, Turkey, Portugal, Greece, Poland, Romania

2.1. NETHERLANDS –RUG

A. National Conferences

- ✓ *Introducing RRI in secondary education,* KNCV Voorjaarsbijeenkomst (May 8, 2014, Bussum)
- ✓ *Project Irresistible,* Meeting Vaksteunpunten Chemistry (September 10, 2014)
- ✓ *The Magic of Mother's Milk - de magie van moedermelk,* 9-maanden-beurs – baby-fair (February 26, 2015)
- ✓ *Startbijeencomk Noord,* RUG University of Groningen, Groningen (September 11, 2015)
- ✓ *Startbijeencomk,* Utrecht (September 30, 2015)

B. International Conferences

- ✓ *The Role of Education in Responsible Research and Innovation*, ICCE Conference, Toronto Canada (July, 13-18, 2014)
- ✓ *Raising awareness about RRI in secondary education,* OPCW Education and Outreach Conference, The Hague, Netherlands (September, 22-23, 2014)
- ✓ *IRRESISTIBLE, Engaging the young with Responsible Research and Innovation,* ECRICE, University of Jyväskyla, Finland (July 9, 2014)
- ✓ *Healthy aging starts with mammae: a better health with smart carbohydrates,* ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)

C. Publications

- ✓ *Project IRRESISTIBLE in Nederland van start/Project IRRESISTIBLE kicks off in the Netherlands,* (October 2, 2014)
- ✓ *Project IRRESISTIBLE: Workshop exhibit design in lissabon,* News article on Science LinX website (**http://www.rug.nl/sciencelinx/nieuws/20141028_lissabon**) (October, 30, 2014)
- ✓ *Irresistible: een onweerstaanbaar project,* News article on Science LinX (September, 2015)

D. Workshops

- ✓ *IRRESISTIBLE project presentation,* Teacher Training Day at University of Groningen (December 17, 2104)

F. Flyers

- ✓ *Oproep docenten Tweede Ronde*, flyers distributed to teachers at Science LinX, Rijksuniversiteit Groningen
- ✓ *Module Koolhydraten in Moedermelk*, flyers distributed to teachers at Science LinX, Rijksuniversiteit Groningen

2.2. ISRAEL –WEIZMANN

A. National Conferences

- ✓ *Solar cells: Should we replace the school's windows with a new development of solar cells that is based on Perovskite?,* National meeting of Israeli chemistry teachers with the participation of 250 teachers (December 23, 2014)
- ✓ *The Irresistible project: RRI in science education",* National science teachers meeting with the participation of 500 teachers (March 29, 2015); poster presentation
- ✓ *Building an ehibition as an alternative assement approach the example of the Irresistible project*, The Academic Arab College for Education in Israel – Haifa (December 2, 2015)
- ✓ Building an ehibition as an alternative assement approach the example of the Irresistible project, The Annual Meeting of Israeli Chemistry Teachers with the participation of 322 teachers, Israel (Barvaz auditorium, Weizmann Institute of Science, December 8, 2015)

B. International Conferences

- ✓ *Presenting the use of the Facebook group in the Israeli Irresistible CoL,* ECRICE, University of Jyväskyla, Finland (July 9, 2014)
- ✓ *Developing a RRI module on the use of photovoltaic windows in schools: design-based research,* ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)

C. Publications

- ✓ *Project IRRESISTIBLE in Nederland van start (Project IRRESISTIBLE kicks off in the Netherlands),* (October 2, 2014)
- ✓ R. Blonder, A. Shaham, E. Zemler (2015): *Under what conditions, if any, would we (the students) agree to have perovskite-based photovoltaic cells installed on the windows of our school?* AlChemy (in Hebrew), 26, 26-32

E. National and other EU project Meetings

- ✓ *Official recognition to teach the Irresistible module in chemistry lessons*, Meeting with the Inspector of Chemistry Education in the of the Israeli Ministry of Education
- ✓ *Official recognition to teach the Irresistible in the school program*, Meeting with the coordinator of "Nahshon" program for excellent students
- ✓ *Sharing articles and establishing a common language*, Meeting with the Israeli PI of other EU projects dealing with RRI (Engage and Parris)

2.3. GERMANY – IPN & DM

B. International Conferences

- ✓ *The Student Curated Exhibition – a New Approach to Getting in Touch with Science,* ECRICE, University of Jyväskyla, Finland (Jyväskyla, July 9, 2014)

C. Publications

- ✓ *Am IPN startet ein neues EU-Projekt: Irresistible*, IPN Blatter (1/2014 – 31, p. 2), ISSN 0179-5775
- ✓ L. Kampschulte, I Parchman (2015): *The student-curated exhibition - A new approach to getting in touch with science*, LUMAT, 3(4), 462-482
- ✓ Projektsitzung am Meer (project meeting at the ocean), article published in a popular German press (Büsum, November 26, 2015)

D. Workshops

- ✓ *IRRESISTIBLE as a best practice example of SiS-EU-projects*, Chamber of Industry and Commerce (Kiel, March 10, 2015)
- ✓ *Presentation to teachers of the two ocean modules ("Plastic – Bane of the Ocean" and "Business Game Offshore Wind Energy") as well as the topic of student exhibitions carried out in the frame of the IRRESISTIBLE project,* IPN Leibniz Istitute of Science and Mathematics Education (Kiel, November 11, 2015)

2.4. TURKEY – BU

A. National Conferences

- ✓ *Öğrenci, öğretmen, uzman ve toplumu birleştiren köprü: Sorumlu araştirma ve inovasyonun fen eğitimine entegrasyonu,* National Science and Mathematics Education Conference, Çukurova University, Adana (September 13, 2014)
- ✓ *Project Irresistible: A project on teacher training, combining formal and informal learning focused on Responsible Research and Innovation*, Seminar for the faculty members at Bogazici University (December 12, 2014)

B. International Conferences

- ✓ *Integrating Responsible Research and Innovation in Science Education through International Collaboration*, Istanbul University Congress Center, Istanbul, Turkey (April 26, 2014)
- ✓ *Teachers' Perceptions of the Community of Learners: The Case of Turkey,* ECRICE, University of Jyväskyla, Finland (July 9, 2014)
- ✓ *Raising Awareness of the Importance of Responsible Research and Innovation among Young People and Science Teachers - The IRRESISTIBLE Project,* (Jan Apotheker, Sevil Akaygün, Gabriel Gorghiu), The International Organization for Science and Technology Education (IOSTE), Turkey (Instanbul, April 24-26, 2015)
- ✓ *Integrating Responsible Research and Innovation to nanoscience applications as extracurricular activity in secondary science education,* ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)

F. Flyers

- ✓ Project flyers distributed at National Science and Mathematics Education Conference, Çukurova University, Adana, Turkey (September 11, 2014)

2.5. PORTUGAL – IE UL

A. National Conferences

- ✓ *Project Irresistible: Portuguese Community of Learners Teachers' Perceptions,* HSCI 2014, Aveiro (July 21-25, 2014)
- ✓ *Projeto irresistible: o desenvolvimento de exposições científicas pelos alunos como estratégia de ação comunitária fundamentada em investigação [IRRESISTIBLE Project: the development of scientific exhibitions by students as a strategy of community action fundend in research],* XVI ENEC - National Encounter of Science Education (Lisbon, September 10, 2015)

B. International Conferences

- ✓ *The empowerment of children for research and collective action about environmental problems: results from the projects 'We Act' and 'Irresistible*, Spain (Murcia, March 18, 2015)
- ✓ *The potential of students planned and designed exhibits about responsible research and innovation – Teachers' perspective* accepted for participation at the Symposium on Responsible Research an Innovation: The role of science education at ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)

D. Workshops

Workshops (face to face and online, through Moodle Platform

- ✓ Workshop 1 (March to July 2014); it involved CoL1 teachers, science educators and scientists and focused on the IRRESISTIBLE project and its distinctive aspects (RRI, scientific cutting edge topics, web2.0 tools and interactive exhibitions). Scientists presented their research themes, shared materials and answered teachers' doubts and questions; teachers builded the first drafts of the teaching modules.
- ✓ Workshop 2 (January to July 2015); it involved CoL1 teachers, science educators and scientists. The workshop focused on RRI and interactive exhibitions development, and aimed at helping teachers, giving them tools to implement the process of exhibition development in their classrooms.
- ✓ Workshop 3 (February 2015): it was planned in cooperation with Ciência Viva (Pavilhão do Conhecimento) and involved CoL2 teachers, who were able to experiment some of the "interactive" exhibits and assess their interactivity; their feedback were collected by Ciência Viva monitors (February 7, 2015)

E. National Meetings

- ✓ *IRRESISTIBLE Exhibitions at 3 schools* (Escola Anselmo de Andrade,Almada; Escola Vale de Milhaços, Corroios; Escola Nun'Alvares, Seixal), open to public (June 2015)

F. Flyers

- ✓ Project flyers distributed at national level

2.6. Finland – UH & JYU

A. National Conferences

- ✓ *Teachers' interests and concerns about teaching of 'Responsible Research and Innovation,* Annual Symposium of the Finnish Mathematics and Science Education Research Association (FMSERA) (Oulu, September 1, 2014)
- ✓ *Diffusion models in the context of RRI,* Symposium of the Finnish Mathematics and Science Education Research Association (FMSERA) 2015
- ✓ *How do primary student teachers incorporate RRI and core ideas into inquiry-based science teaching?* Symposium of the Finnish Mathematics and Science Education Research Association (FMSERA) 2015

B. International Conferences

- ✓ *Research-based development of out-of-school learning environments on contemporary research,* Nordic Research Symposium on Science Education (NFSUN), Finland (Helsinki, June 5, 2014)
- ✓ *IRRESISTIBLE – Engaging the Young with Responsible Research and Innovation,* HOPE Annual Forum 2014 – Inspiring young people to study physics Finland (Helsinki, August 27-30, 2014)
- ✓ *Teachers' interests and concerns about teaching of Responsible Research and Innovation,* ECRICE, University of Jyväskyla, Finland (Jyväskyla, July 9, 2014)
- ✓ *Presentation of the poster symposium on Irresistible,* ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)
- ✓ *Teachers' interests and concerns related to the teaching of "Responsible Research and Innovation",* ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)

C. Publications

- ✓ *IRRESISTIBLE-hanke: huippututkimuksen yhteiskunnallisuutta tiedeopetukseen,* LUMA Sanomat (LUMA.fi) (September 23, 2014)
- ✓ *STEM education with a focus on responsible research,* LUMA News (LUMA.fi/news) (September 24, 2014)

2.7. Italy – UNIBO & UNIPA

A. National Conferences

- ✓ *Congegni e macchine a livello molecolare (Molecular devices and machines),* SPAIS Training School for Teachers of Experimental Sciences, (Palermo, July 21 – 25, 2014)

B. International Conferences

- ✓ *Responsible Research and Innovation in Science Education: The IRRESISTIBLE Project*, GIREP - MPTL 2014 Teaching/Learning Physics: integrating research into practice, Italy (Palermo, July 7 – 12, 2014); poster presentation
- ✓ *Responsible Research and Innovation in Science Education: The IRRESISTIBLE Project*, SIS-RRI Conference, Italy (Rome, November 19-21, 2014); poster presentation
- ✓ *The IRRESISTIBLE project in Science Education: How can RRI become a permanent aspect of science teaching?* IOSTE Eurasia Regional Symposium & Brokerage Event, Turkey (Istanbul, April 24-26, 2015,); poster presentation
- ✓ *How can RRI become a permanent aspect of science teaching?* ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)

C. Publications

- ✓ E. Bertozzi, C. Fazio, A. Floriano, O. Levrini, R. Maniaci, B. Pecori, M. Venturi, J. Apotheker: *Responsible Research and Innovation in Science Education: The IRRESISTIBLE Project*, in Proceedings of GIREP-MPTL 2014 International Conference Teaching/Learning Physics: Integrating Research into practise, University of Palermo (July 22-26, 2014)
- ✓ *Progetto Irresistible: nanotecnologie ed etica, successo dell'IIS "Nobili",* Newspaper La Stampa (March 20, 2015)
- ✓ *Ricerca: "irresistibile" e responsabile,* Newspaper Il Sole 24 Ore (November 23, 2015)

D. Workshops

- ✓ *The environment of the university research - The IRRESISTIBLE project*, Conference within the course "Out of the Box" - innovation competences between school, research and entrepreneurship, organized by Regional school-office of Emilia-Romagna and addressed to teachers and principals of the secondary school (April 27, 2015, Lyceum "Galvani", Bologna)

E. National Meetings

- ✓ *I limiti estremi della miniaturizzazione: congegni e macchine a livello molecolare (Extreme miniturization: molecular devices and machines),* Teacher Training Course at the Museo of Balì, (September 3, 2014, Saltara, PU)
- ✓ *Il progetto Irresistible*, EsperienzaInsegna (Palermo, February, 2015)

2.8. Greece – UOC & EF

Greece – UOC

A. National Conferences

- ✓ *Χρήση Εργαλείων web 2.0 για την επιμόρφωση εκπαιδευτικών σε θέματα Νανοτεχνολογίας. Το πρόγραμμα IRRESISTIBLE (Using Web 2.0 tools in teachers' training activities about Nanotechnology. The Irresistible-project),* 9th National Conference on ICT in Education, University of Crete (Rethymno, October 4, 2014)
- ✓ *Αλληλεπίδραση Εκπαίδευσης, Επιστημονικής Έρευνας και Κέντρων Φυσικών Επιστημών για την Ανάπτυξη Διδακτικής Ενότητας Νανοτεχνολογίας: το πρόγραμμα Irresistible* (*Interaction of Education, Scientific Reseach & Science Center in developing a Nanotechnology Module: The Irresistible Project)*. Symposium including the following presentations: a) *Teacher Training in Developing a teaching Module on Nanotechnology in the* Framework *of a Community of Learners* b) *Implementation of the Teaching Module on Nanotechnology* c) *Science Communication through Interactive Exhibits related to RRI issues in Nanotechnology* and d) *Using ICT in teachers and students education in Nanotechnology*. 9th National Conference on Science Education & ICT, School of Education, Aristotle University of Thessaloniki, Greece (Thessaloniki, May 9, 2015).

B. International Conferences

- ✓ *Responsible Research and Innovation in Science Education: The IRRESISTIBLE Project,* 1st International Conference on: New Developments in Science and Technology Education (NDSTE), Greece (Corfu, May 29, 2014); poster presentation
- ✓ *Irresistible-Project: The Community of Learners in Greece, ECRICE,* University of Jyväskyla, Finland (Jyväskyla, July 9, 2014)
- ✓ *The Model of Educational Reconstruction as a Research Framework for Teaching and Learning Modern Science Topics,* ESERA 2014 Summerschool, Turkey (Kapadokya, August 24, 2014); plenary lecture
- ✓ *Teachers' Training in Developing Nanoscience and Nanotechnology Teaching Modules,* ESERA 2014 Summerschool, Turkey (Kapadokya, August 24, 2014)
- ✓ *Science teachers' training in developing nanoscience and nanotechnology teaching module,* ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)
- ✓ *RRI and nanotechnology: developing a teaching module and exhibits for primary and secondary students,* ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)

C. Publications

- ✓ M. Kalogiannakis, D. Stavrou: *Χρήση Εργαλείων web 2.0 για την επιμόρφωση εκπαιδευτικών σε θέματα Νανοτεχνολογίας. Το πρόγραμμα IRRESISTIBLE (Using Web 2.0 tools in teachers' training activities about Nanotechnology. The Irresistible-project),* in Proceedings of the 9th National Conference ICT in Education, P. Anastasiadis, N. Zaranis, V. Ikonomidis, M. Kalogiannakis.(Eds.), Rethymno, University of Crete, Greece, (October, 3-5, 2014), pp. 263 – 270

D. Other EU project Meetings - Conferences

- ✓ *Διδασκαλία των Φυσικών Επιστημών με Διευρεύνηση (Teaching Science with Inquiry),* 1st National Conference of the EU-Project Chain Reaction Heraklion, Crete (March 29, 2014)
- ✓ *Το Ευρωπαϊκό Πρόγραμμα IRRESISTIBLE και η εφαρμογή του σε μαθητές Β΄Λυκείου (The European Project IRRESISTIBLE and its application to upper secondary students),* 2nd Conference

Chain Reaction (Fp7- EU-Project), Chemistry Department, University of Crete (Heraklion, March 21, 2015)

- ✓ *Irresistible: Νανοτεχνολογία & Νανοϋλικά (Irresistible: Nanotechnology & Nanomaterials),* 2nd Conference Chain Reaction (Fp7- EU-Project), Chemistry Department, University of Crete (Heraklion, March 21, 2015)

E. National Meetings

- ✓ *IRRESISTIBLE Exhibition***,** Public opening, Natural History Museum, University of Crete (Heraklion, May 3, 2015)

F. Flyers

- ✓ *Responsible Research and Innovation in Science Education: The IRRESISTIBLE Project*, distributed during the CoL Meeting Heraklion – Rethymno, Greece (Crete, June 26-28, 2014)
- ✓ *Responsible Research and Innovation in Science Education: The IRRESISTIBLE Project*, distributed during the CoL Meeting Eugenides Foundation, Greece (Athens, October11-12, 2014)

2.8. Greece – EF

A. National Conferences

- ✓ *Science communication through interactive exhibits on Responsible Research and Innovation in Nanotechnology,* 9th Greek Congress, Science Education and ICT in Education: Teaching and Learning in Science and Technology: Research, Innovation and Practices (Thessaloniki, May 8-10, 2015)
- ✓ *Irresistible: Νανοτεχνολογία & Νανοϋλικά (Irresistible: Nanotechnology & Nanomaterials),* 2nd Conference Chain Reaction (Fp7- Eu-Project), Chemistry Department, University of Crete (March 21, 2015)

B. International Conferences

- ✓ *RRI and nanotechnology: Developing a teaching module and exhibits for primary and secondary students*, ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)

E. National Meetings

- ✓ *IRRESISTIBLE Exhibition***,** Public opening, Interactive Science and Technology Exhibition Hall, Eugenides Foundation (Athens, May 3, 2015)
- ✓ *European Museums Night,* Presentation of IRRESISTIBLE Exhibition to the general public, Interactive Science and Technology Exhibition Hall, Eugenides Foundation (Athens, May 16, 2015)

2.9. Poland – JU

A. National Conferences

- ✓ *Wystawa 2.0. Projekt IRRESISTIBLE w Muzeum UJ. Wystawy objazdowe w Muzeum UJ.*, VI Konferencja Interakcja-Integracja, Poland (Gdynia, 12-14 February 2014)
- ✓ *Exhibition 2.0. Project IRRESISTIBLE in the Jagiellonian University Museum*, 6th Conference Interaction-Integration, Science Center Experiment, Gdynia, Poland, (March 14, 2014)
- ✓ *Project IRRESISTIBLE. The interactive exhibition as a sum of the student projects,* XIV Meeting of the Club of Physics Demonstrators, Rzeszów University of Technology (June 24, 2014)
- ✓ *Zastosowanie WEB2.0 w kształceniu nauczycieli elementem projektu 7PR IRRESISTIBLE,* Annual Meeting of Polish Chemical Society, Czestochowa (September 17, 2014); poster presentation
- ✓ *Odpowiedzialne badania i innowacje – moda czy konieczność?,* Congress of the Polish Association of Teachers of Science Education (Toruń, September 13, 2014)
- ✓ *Projekt IRRESISTIBLE,* Science picnic, Warszawa (May 31, 2014); poster presentation
- ✓ *Projekt IRRESISTIBLE,* Science picnic, Rzeszów (June 7, 2014); poster presentation
- ✓ *Nanonauki i nanotechnologia – prawdy i mity*, Conference teachers & teachers educators from Poland; Krakow (June 19-20, 2015); plenary lecture
- ✓ *W trójkącie: pracownia badawcza - muzeum naukowe – szkoła,* Conference teachers & teachers educators from Poland; Krakow (June 19-20, 2015); oral presentation
- ✓ *Muzeum jako miejsce edukacji nieformalnej w dziedzinie nauk przyrodniczych,* Conference teachers & teachers educators from Poland; Krakow (June 19-20, 2015)
- ✓ *Projekt IRRESISTIBLE w Liceum Ogólnokształcącym nr III im. Wł. Broniewskiego w Ostrowcu Świętokrzyskim*, Conference teachers & teachers educators from Poland (Krakow, June 19-20, 2015)
- ✓ *Realizacja zajęć szkolnych w ramach projektu IRRESISTIBLE*, Conference teachers & teachers educators from Poland (Krakow, June 19-20, 2015)
- ✓ *Eksperymenty naukowe w projekcie* IRRESISITIBLE, Conference of The Polish Association of Science Teachers (Toruń, September 13, 2014); poster
- ✓ *Podróż w głąb katalizatora – wybrane materiały dydaktyczne dla nauczycieli chemii i przyrody licealnej opracowane w ramach projektu 7PR IRRESISTIBLE*, The 58th Annual Meeting of the Polish Chemical Society, Poland (Gdańsk, September 21- 25, 2015), poster
- ✓ *Idea odpowiedzialnych badań i innowacji w kształceniu uczniów i studentów*, II Ogólnopolska Konferencja Dydaktyków Szkół Wyższych Wydziałów Przyrodniczych (Warszawa, November 19-20, 2015)

B. International Conferences

- ✓ *Raising youth awareness to responsible Research and Innovation through Inquiry Based Science Education,* 3rd International Seminar Science-Society-Didactics New Society-New Professions, Kraków, Poland (April 8, 2014)
- ✓ *Museum education as a part of science teaching and learning,* 2nd International Congress of Science Education, Foz do Iguacu (August 27-30, 2014)
- ✓ *Community of learners and its role in the FP7 Irresistible Project – Jagiellonian University Example,* 6th International Conference on Research in Didactics of the Sciences, DidSci 2014 (Krakow, June 25, 2014); poster presentation
- ✓ *Teacher Training at Chemistry Faculties – Mutual Benefits? A Case Study Based on the Example of the IRRESISTIBLE Project*, IUPAC 2015, Korea (Busan, August 9-14, 2015)

- ✓ *Interactive exhibition prepared by students as a tool of informal education in a museum*, CIMUSET Conference 2015, Poland (Krakow, September 6-11, 2015)

C. Publications

- ✓ *I.Maciejowska, Pomiedzy Nauka, Technologia i Edukacja*, Orbital: Magazine of Polish Chemical Society (June 2, 2014)
- ✓ M. Kluza, M. Krzeczkowska, I. Maciejowska, J. Apotheker *Museum education as a part of science teaching and learning,* Journal of Science Education, Proceedings of the 2d International Congress Of Science Education 2014, Vol. 15 (Special Issue), 2014, p. 102
- ✓ I. Maciejowska, J. Apotheker*: Raising Youth Awareness to Responsible Research and Innovation through Inquiry Based Science Education,* Annales Universitatis Paedagogicae Cracoviensis, Studia ad Didacticam Biologiae Pertinentia IV, 2014, 119-126
- ✓ I. Maciejowska: *Dobrze wykorzystać czas przeznaczony na przedmiot uzupełniający przyroda? - propozycje projektu IRRESISTIBLE,* Niedzialki, 4/2014, p. 78-83
- ✓ I. Maciejowska (2015). *Kilka słów o tym po co nam przyroda w liceum i jak można sobie z nią poradzić,* Nauczanie Przedmiotów Przyrodniczych, 53 (1), *26-29*
- ✓ B.Kajda (2015):, *Spotkanie uczniów Zespołu Szkół Rolnicze Centrum Kształcenia Ustawicznego w Czernichowie z naukowcami na Wydziale Chemii Uniwersytetu Jagiellońskiego w Krakowie*, Orka, n.6 2015, p.14
- ✓ B.Kajda *(2015): Z radością zakończyli kolejny projekt*, Orka, n. 8, 2015, p.14
- ✓ B. Kajda (2015): *Młodzież z ZSRCKU w Czernichowie realizuje projekty*, Hejnał Oświatowy**,** n. 6-7/144 / 2015, p.21
- ✓ M. Krzeczkowska, I. Maciejowska, J. Apotheker, R. Blonder,S. Rosenfeld (2015): *Zespół Osób Uczących się jako propozycja rozwoju kompetencji nauczycieli i podnoszenia jakości pracy szkoły,* w: Z CHEMIĄ ku przyszłości (161-174), Lublin, Polska: Wydawnictwo UMCS
- ✓ I. Maciejowska, J. Apotheker (2015): *Teacher Training at Chemistry Faculties – Mutual Benefits? A Case Study Based on the Example of the IRRESISTIBLE Project*, Gamtamokslinis Ugdymas. Natural Science Education*,* 12(2), 104-111
- ✓ I. Maciejowska, M. Krzeczkowska (2015): *Badania naukowe – jednym z tematów lekcji przyrody. Propozycje projektu IRRESISTIBLE* cz. II, Niedziałki, 100 (3), 65-73

D. Workshops

- ✓ *Odpowiedzialne badania i innowacje – moda czy konieczność?*, Congress of the Polish Association of Science Teachers (Torun, September 13, 2014)

E. National Meetings

- ✓ *Co nowego w projektach skierowanych do nauczycieli przedmiotów przyrodniczych w ramach 7. Programu Ramowego ESTABLISH, SAILS oraz IRRESISTIBLE?,* Conference for Science Teachers (Krakow, November 22, 2013)
- ✓ *Stosowanie metod IBSE w kontekście odpowiedzialnych badań i innowacji. IRRESISTIBLE - nowy projekt realizowany na WCh UJ.,* Conference for Science Teachers (Krakow, April 11, 2014)

F. Flyers

- ✓ IRRESISTIBLE project Flyer distributed during the Annual Meeting of Polish Chemical Society, Czestochowa (September 17, 2014)
- ✓ IRRESISTIBLE project Flyerdistributed during the Congress of the Polish Association of Teachers of Science Education (Toruń, September 13, 2014)
- ✓ IRRESISTIBLE project Flyer distributed at School of Didactics of Chemistry, Janów Lubelski (June 20, 2014)
- ✓ IRRESISTIBLE project flyer distributed during the 2nd International Congress of Science Education (August 27-30, 2014)

2.10. Romania – VUT

A. National Conferences

- ✓ G. Gorghiu, L. M. Drăghicescu, R. L. Olteanu, L. M. Gorghiu: *Stimularea interesului elevilor pentru învăţarea Ştiinţelor prin activităţi desfăşurate în contexte non-formale – Sesiunea anuală de comunicări ştiinţifice a cadrelor didactice,Facultatea de Ştiinţe şi Arte* (Târgovişte, June 15, 2014)
- ✓ G. A. Anghel: *Bune practici în predarea Ştiinţelor* (*Presentation of IRRESISTIBLE Project*), Seminarul STEM – Practici inovative de predare a științelor (Târgoviște, April 25, 2015)

B. International Conferences

- ✓ *Related Applications of Nanotechnology and Nanomaterials in Medicine Presented in Formal and Non-Formal Learning Contexts*, 12th European Conference on Research in Chemical Education New Trends in Research-based Chemistry Education (ECRICE 2014), Finland (Jyväskylä, July 7-10, 2014)
- ✓ *Promoting Responsible Research and Innovation through a Specific Teaching Module on Nanomaterials*, 12th European Conference on Research in Chemical Education New Trends in Research-based Chemistry Education (ECRICE 2014), Finland (Jyväskylä, July 7-10, 2014)
- ✓ *Enhancing the Young Students Competences in Science and Technology in Formal and Non-formal Educational Contexts*, The International Valorisation Conference Key Methodology to Successful Competence Based Learning (KEYS 2014), Atasehir, Turkey (Istanbul, October 16-18, 2014)
- ✓ *Students' Perception Related to a Responsible Research and Innovation Demarche*, The 6th International Conference EduWorld 2014 Education Facing Contemporary World Issues, Romania (Piteşti, November 7-9, 2014)
- ✓ *Non-formal Education - Frame for Responsible Research and Innovation Demarches*, The 6th International Conference EduWorld 2014 Education Facing Contemporary World Issues, Romania (Piteşti, November 7-9, 2014)
- ✓ *An Approach Related to Nanotechnology/Nanobiomimetics in the Context of a Non-formal Educational Activity*, The 5th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2014) Transdisciplinarity and Communicative Actions, Romania (Târgovişte, November 21-22, 2014)
- ✓ *The Role of the Libraries in Promoting the Responsible Research and Innovation*, The 5th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2014) Transdisciplinarity and Communicative Actions, Romania (Târgovişte, November 21-22, 2014)
- ✓ *The Public Library and its Involvement in Non-formal Learning Activities*, The 6th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2015) Rethinking Social Action. Core Values, Romania (Iaşi, April 16-18, 2015)
- ✓ *Raising Awareness of the Importance of Responsible Research and Innovation among Young People and Science Teachers - The IRRESISTIBLE Project*, IOSTE Eurasian Regional Symposium & Brokerage Event Horizon 2020 - Science with and for Society Symposium, Turkey (Istanbul, April 24-26, 2015)
- ✓ *Formal science education activities on nanomaterials designed to promote RRI concepts*, ESERA 2015, Finland (Helsinki, August 31-September 4, 2015)
- ✓ *Facilitating the Understanding of Responsible Research and Innovation Dimensions in Non-formal Education Activities Organized in Museums*, Central and Eastern European LUMEN Conference: New Approaches in Social and Humanistic Sciences (NASHS 2015), Republic of Moldova (Chişinău, September 11-13, 2015)

- ✓ *A Modern Approach on Teaching Science Oriented on Responsible Research and Innovation Aspects*, Central and Eastern European LUMEN Conference: New Approaches in Social and Humanistic Sciences (NASHS 2015), Republic of Moldova (Chişinău, September 11-13, 2015)
- ✓ *Valorization of RRI Dimensions in Non-Formal Education. A Case Study Related on a Thematic Exhibition in Museum*, The 7th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2015) Multidimensional Education and Professional Development. Ethical Values (MEPDEV 2015), Romania (Târgovişte, November 12-14, 2015)
- ✓ *The Relationship of Cyberspace and Information Literacy in Libraries with Impact in Non-Formal Education*, The 7th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2015) Multidimensional Education and Professional Development. Ethical Values (MEPDEV 2015), Romania (Târgovişte, November 12-14, 2015)
- ✓ *Responsible Research and Innovation in Non-Formal Education Activities Related to Solar Energy Area*, The 7th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2015) Multidimensional Education and Professional Development. Ethical Values (MEPDEV 2015), Romania (Târgovişte, November 12-14, 2015)
- ✓ *The World of Nanomaterials and Solar Energy in the Perception of General Public*, The 7th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2015) Multidimensional Education and Professional Development. Ethical Values (MEPDEV 2015), Romania (Târgovişte, November 12-14, 2015)

C. Publications

- ✓ G. Gorghiu, G. A. Anghel, M. R. Ion (2015): *Students' Perception Related to a Responsible Research and Innovation Demarche*, Procedia - Social and Behavioral Sciences, 180, pp. 600-605
- ✓ A. M. A. Petrescu, G. Gorghiu, R. A. Lupo (2015): *Non-formal Education - Frame for Responsible Research and Innovation Demarches*, Procedia - Social and Behavioral Sciences, 180, pp. 682-687
- ✓ G. A. Anghel, A. T. Erich, L. M. Drăghicescu (2015): *The Role of the Libraries in Promoting the Responsible Research and Innovation*, in Proceedings of the 5th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2014) Transdisciplinarity and Communicative Actions, A. Frunză, T. Ciulei, A. Sandu (Eds.), Romania (Târgovişte, November 21-22, 2014) Medimond International Proceedings, pp. 33-36
- ✓ G. Gorghiu, C. Antonescu, G. State, A. M. A. Petrescu (2015): *An Approach Related to Nanotechnology/Nanobiomimetics in the Context of a Non-formal Educational Activity,* in Proceedings of the 5th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2014) Transdisciplinarity and Communicative Actions, A. Frunză, T. Ciulei, A. Sandu (Eds.), Romania (Târgovişte, November 21-22, 2014) Medimond International Proceedings, pp. 319-324

D. Workshops

- ✓ *Nanoştiinţele şi cercetarea responsabilă (Nanoscience and Responsible Research),* Workshop organized at History Museum Targoviste, Targoviste, Romania (April 9, 2014)
- ✓ *Instrumente multimedia pentru promovarea conceptului de Cercetare şi Inovare Responsabilă în cercetarea muzeală (Multimedia Instruments for Promoting the Concept of Responsible Research and Innovation in Museum Practices),* Workshop organized at Prahova Natural Science Museum, Ploieşti, Romania (May 14, 2014)
- ✓ *Cercetare şi inovare responsabilă în domeniul Nanotehnologiilor (Responsible Research and Innovation in the Area of Nanotechnology),* Workshop organized at Dambovita County "Ion Heliade Rădulescu" Library, Targoviste, Romania (June 4, 2014)
- ✓ *Nanobiomimetica şi Cercetarea Responsabilă (Nanobiomimetics and Responsible Research),* Workshop organized at National College "Constantin Cantacuzino" Targoviste, Romania (October 9, 2014)

- ✓ *Applications of nanomaterials in industry,* Workshops dedicated to teachers and students - organized in the special Week: "School, in another way - To know more, To be the best!" (April 6, 2015, Valahia University Targoviste Campus)*
- ✓ *Applications of nanomaterials in renewable energy technologies,* Workshops dedicated to teachers and students - organized in the special Week: "School, in another way - To know more, To be the best!" (April 8, 2015, Valahia University Targoviste Campus - Multidisciplinary Scientific & Technological Research Institute)*
- ✓ *History of nanomaterials. Applications of nanomaterials in practice,* Workshops dedicated to teachers and students - organized in the special Week: "School, in another way - To know more, To be the best!" (April 9, 2015, Ion Heliade Rădulescu, Dambovita County Library)*
- ✓ *Applications of nanomaterials in museum research,* Workshops dedicated to teachers and students - organized in the special Week: "School, in another way - To know more, To be the best!" (April 10, 2015, Prahova Natural Science Museum)*
- ✓ *The World of Nanomaterials and Solar Energy*, Workshops dedicated to teachers and students - organized with the occasion of the special Event: "European Researcher's Night" (September 25, 2015), History Museum Targoviste, Targoviste, Romania.
- ✓ *Best practices in Science education, with an emphasis on exploiting the Responsible Research and Innovation dimensions*, Workshop dedicated to teachers and researchers - organized in the frame of the 7th International Conference Logos, Universality, Mentality, Education, Novelty (LUMEN 2015) Multidimensional Education and Professional Development. Ethical Values (MEPDEV 2015), Romania (Târgovişte, November 13, 2015), Valahia University Targoviste Campus - Multidisciplinary Scientific & Technological Research Institute, Romania.

F. Flyers

- ✓ Project flyers distributed at national level

*In total, more than 1000 young students and 30 school teachers participated to the Workshops organized during the Week: "School, in another way - To know more, To be the best!". The list of participants can be consulted at: http://irresistible.ssai.valahia.ro/main/elevi?cod=xoxo

3. CONCLUSION

As this deliverable clearly evidences, during the first 24 months of the project the partners have been strongly involved in several types activities aimed at disseminating the goals and the peculiar features of the IRRESISTIBLE project.

Several stakeholders have been approached and several channels have been used. Teachers and researchers, both from the project and from other networks and projects, policymakers, and media representatives have been informed by means of (a) participation in national and international Conferences in Teacher Training and Science Education (87 presentations), and local workshops and meetings (29 presentations); (b) publication of 31 articles in national and international science education journals and popular newspapers; (c) preparations of flyers that have been distributed by the partners attending to conferences, workshops and seminars; (d) preparation of videos, illustrating the activities performed by students and teachers participating in the project, that have been shown in schools and in meetings with policymakers, and media representatives.

Other important channels to spread the ideas, concepts and education methodology at the base of the project have been, and will also be in the future, (e) the IRRESISTIBLE website that provides information about the project; (f) Facebook pages at national level to inform younger users; (g) newsletter and blog in which the performed activities are published and advertised.

Up to now the activities have been focused on attracting teachers and others to the project. In the next 12 months they will be focusing more on disseminating the results obtained in the frame of the project, especially those that are new such as the (changing) attitudes of the participating teachers, the combination of cutting edge science and RRI, and the use of exhibitions as a learning and assessment tool.

All these efforts will surely contribute to close the gap between scientific research and science education and to ensure a more scientifically literate, responsible, and creative society that are the most important aims of the IRRESISTIBLE project.

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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').

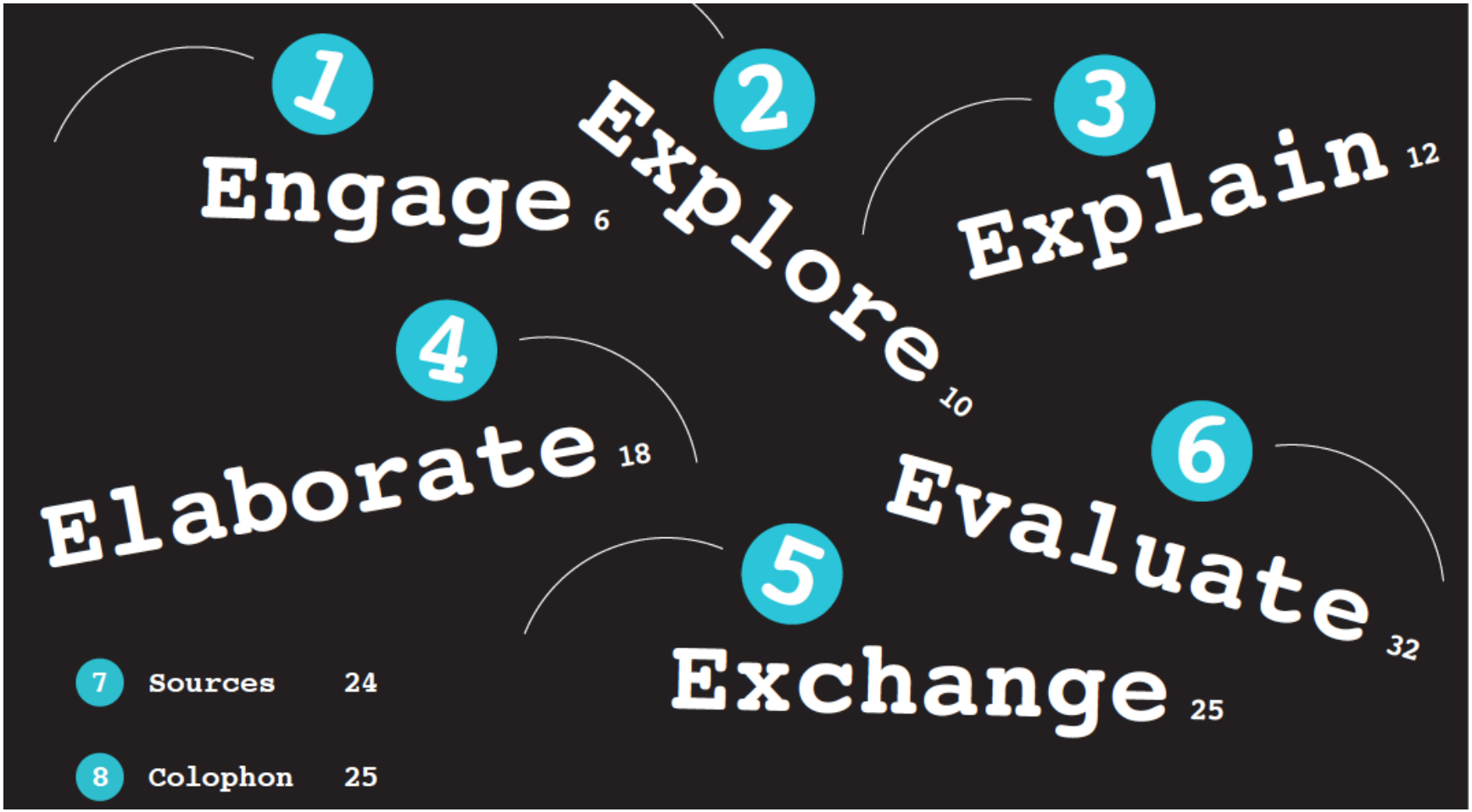
Community of Learners

- 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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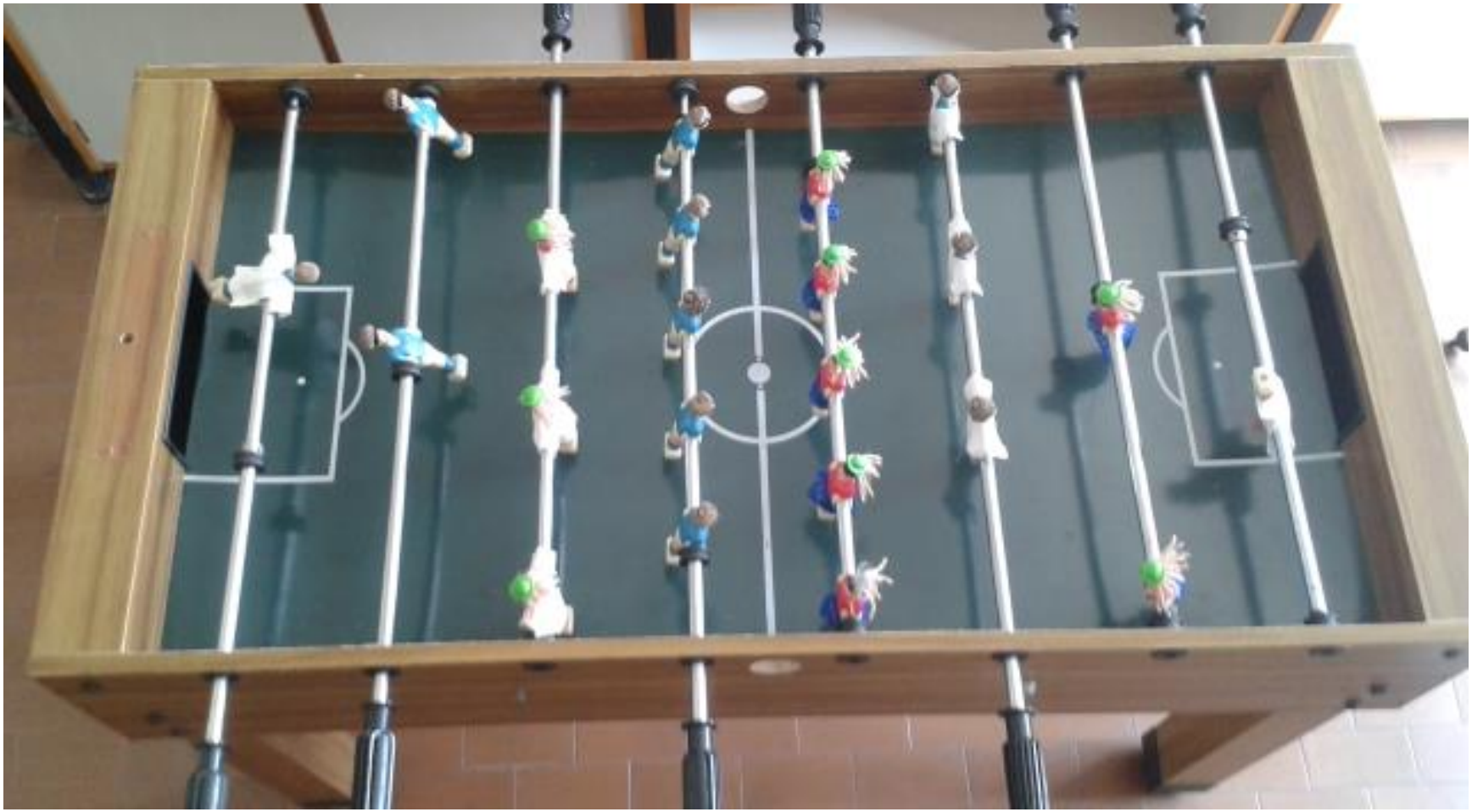
Football game



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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

Irresistible

- This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 612367.

- It is a coordination and support action under FP7-SCIENCE-IN-SOCIETY-2013-1, ACTIVITY 5.2.2 Young people and science: Topic SiS.2013.2.2.1-1 Raising youth awareness to Responsible Research and Innovation through Inquiry Based Science Education.
- http://www.irresistible-project.eu/index.php/en/

Teachers' interests and concerns related to the teaching of "Responsible Research and Innovation"

Miikka de Vocht[1], Antti Laherto[1], and Ilka Parchmann[2]

[1]Department of Physics, University of Helsinki, Finland

[2]Leibniz Institute for Science and Mathematics Education, University of Kiel, Germany

Teachers as learners and innovation adopters

- Teachers are keen learners motivated by personal interests, students' interests and school's interests
- Teacher learning can depend on (1) constructivist staff development (2) opportunities for interaction with colleagues and experts (3) old structures and thought patterns as barriers (4) testing culture (Davis 2003)
- Even after learning, teachers can decide to abandon the innovation

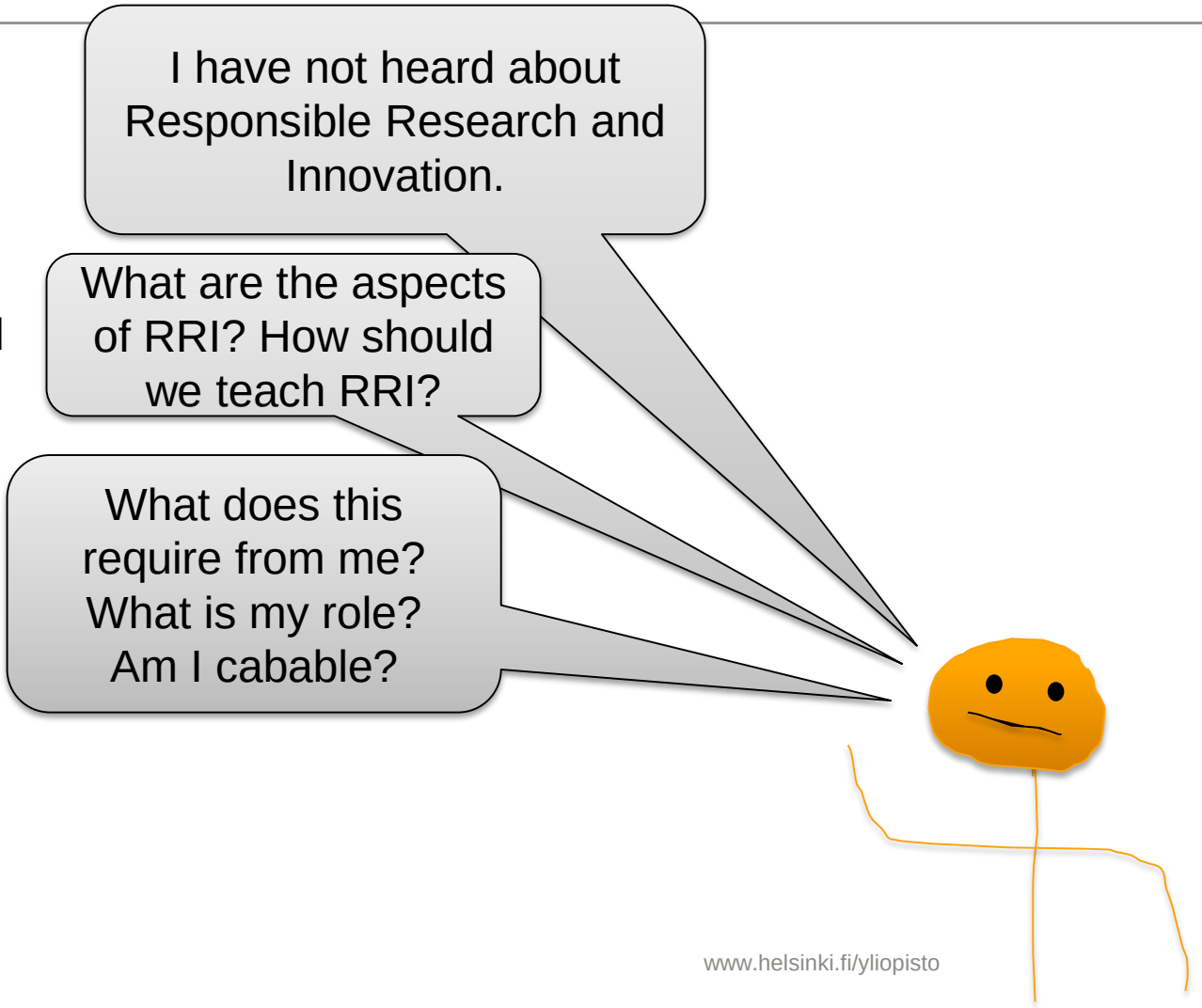
Implementing Responsible Research and Innovation (RRI) in IRRESISTIBLE

- Teachers in an EU project IRRESISTIBLE are incorporating RRI into teaching modules in the following ways…

Engagement	Within IRRESISTIBLE, researchers work with students, teachers and science museum experts. School students are taught about the role of different societal actors.
Equality	Within IRRESISTIBLE, equality is taken into account in teaching methods and in teaching content. Students receive a realistic and diverse impression of scientists.
Science Education	IRRESISTIBLE uses teaching methods, such as inquiry-based learning, to promote interests in science equally.
Open Access	Students are taught about the role of scientific information in society.
Ethics	Ethical issues related to research, the effects of applications on health and the environment and the social acceptability of science.
Governance	For example, students are allowed to 'assume' different roles in society.

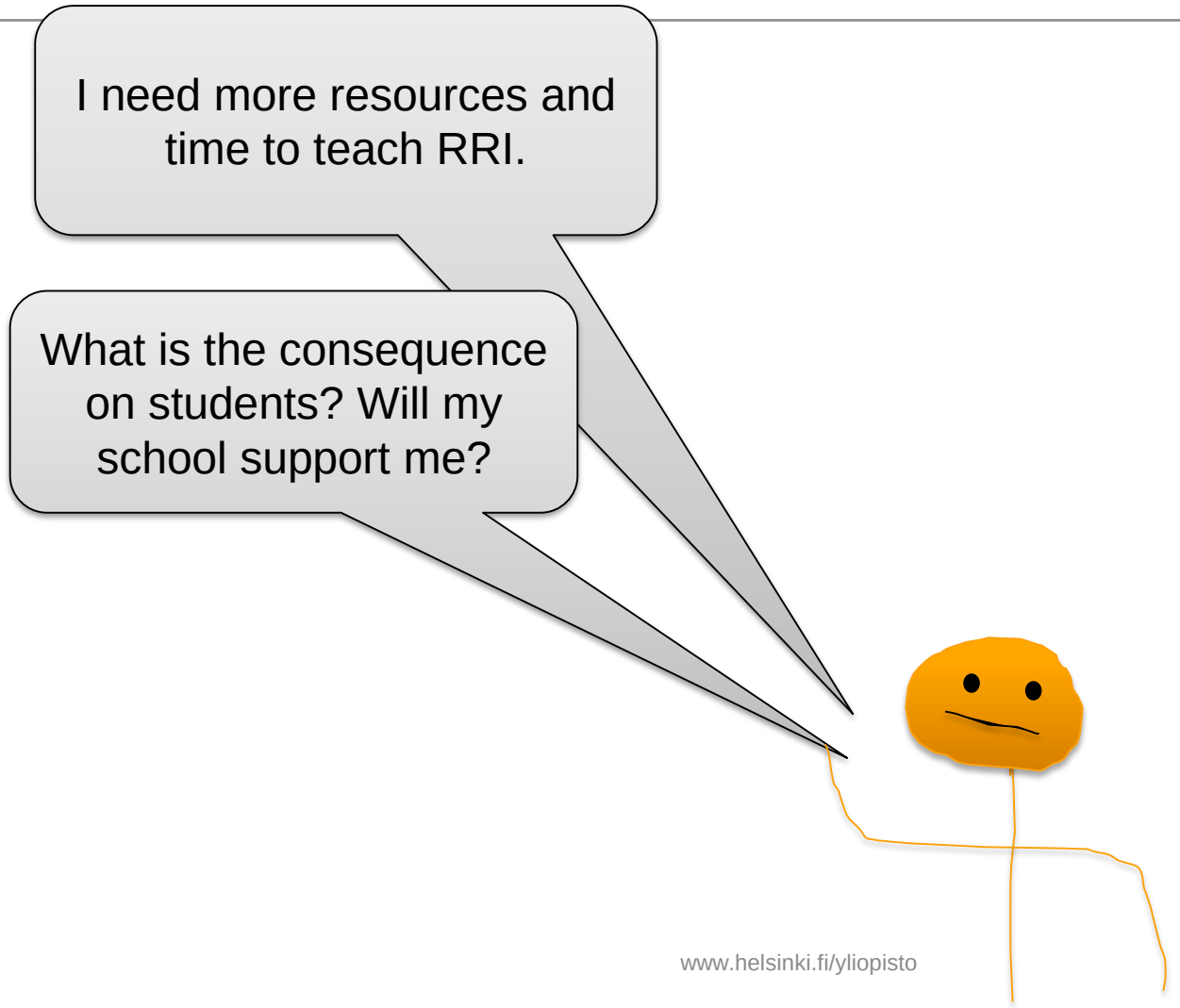
Stages of Concerns-questionnaire: an instrument of Concerns-Based Adoption Model (Hall & al. 1977)

- 0: Awareness
- 1: Informational
- 2: Personal



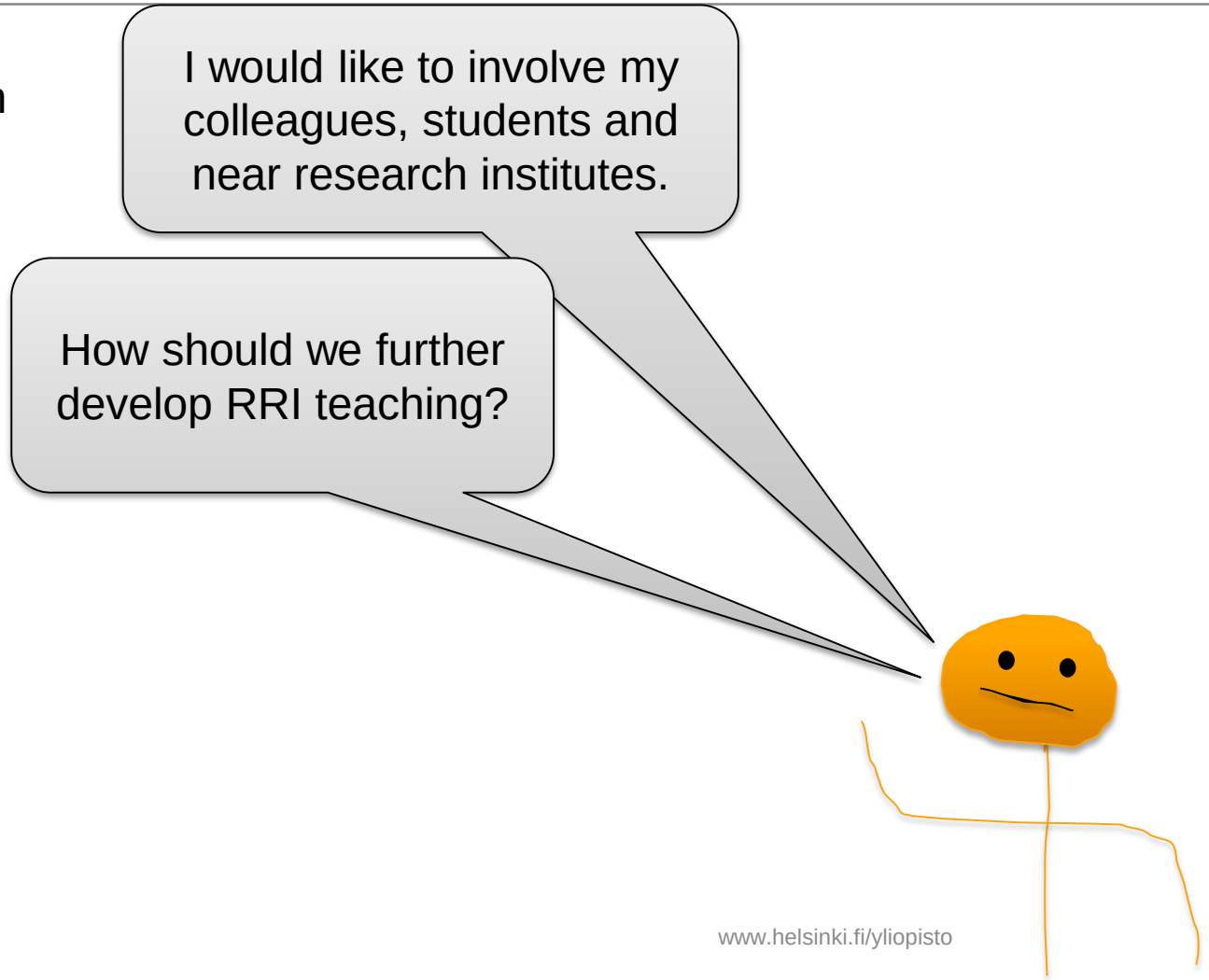
Stages of concerns

- 3: Management
- 4: Consequence



Stages of concerns

- 5: Collaboration
- 6: Refocusing



SoC-profile types

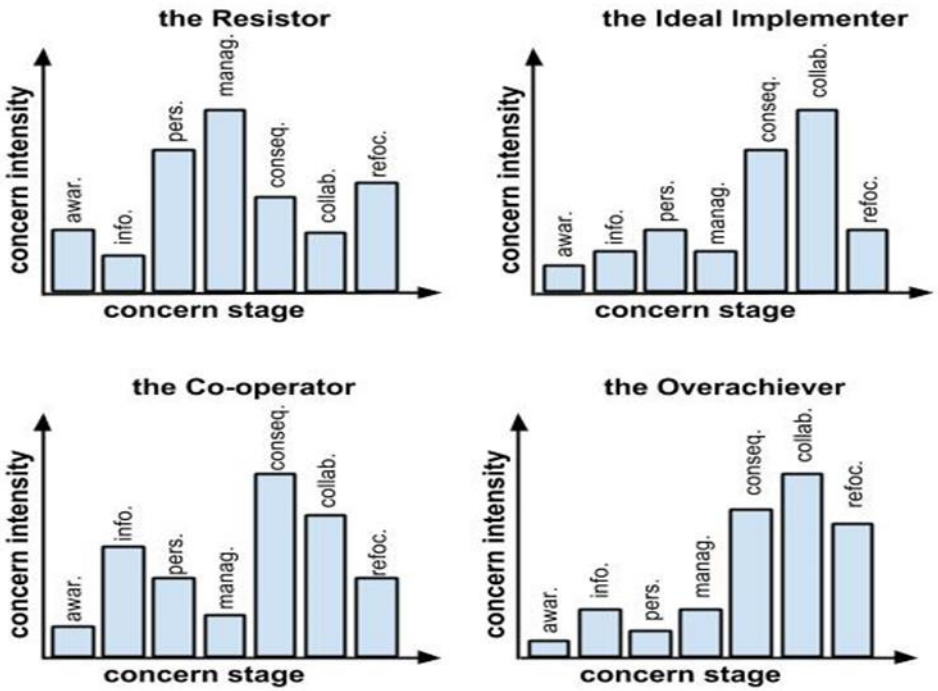
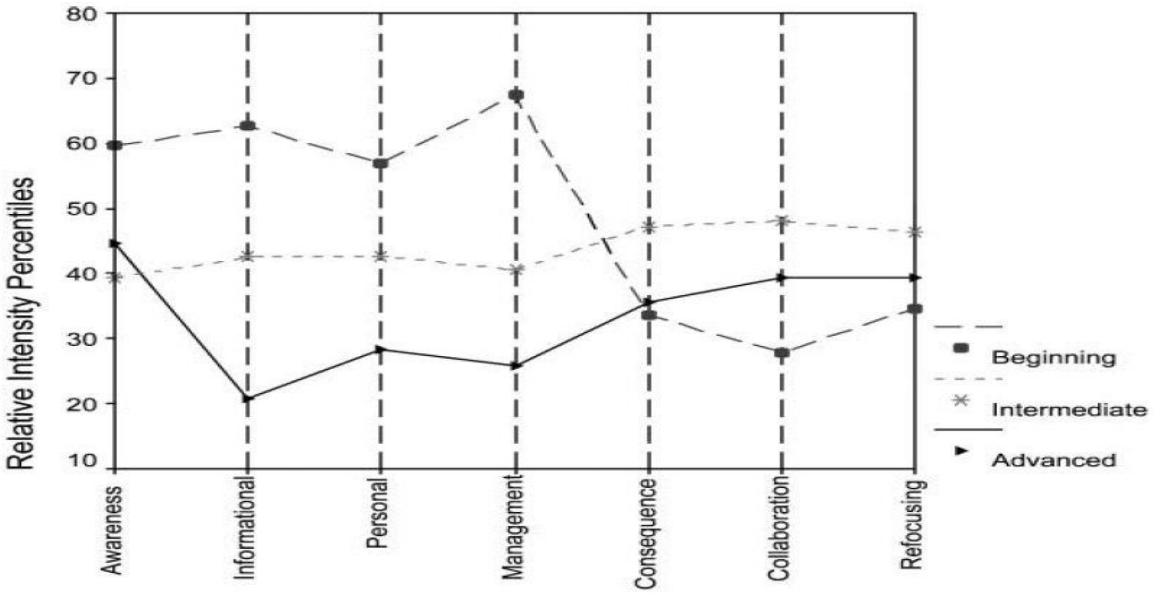


Figure 3 Profile type of a the Resistor, the Ideal Implementer, the Co-operator and the Overachiever (redrawn based on Hollingshead 2009)

Previous studies

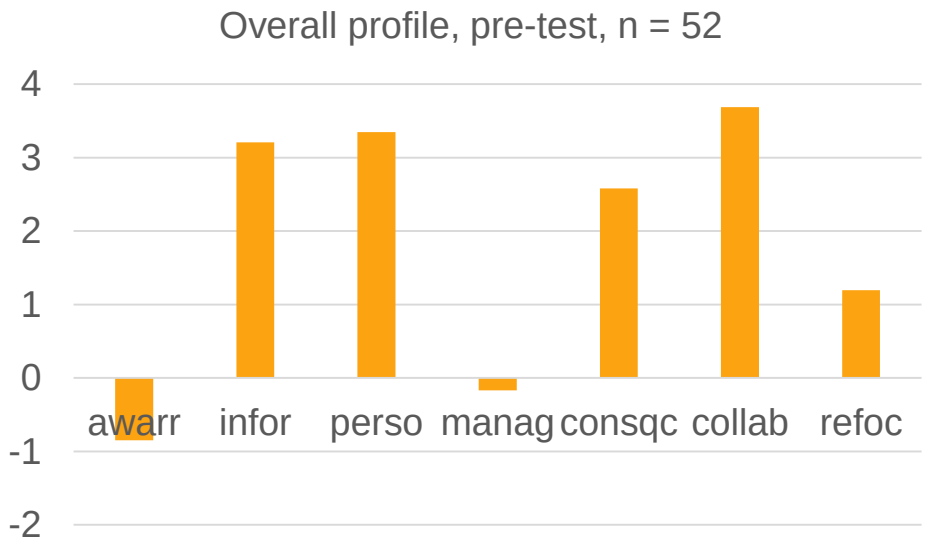


- *Figure 3.* SoC profile of 80 teacher students who participated in a technology integration course (Liu 2005). Low-level stages were resolved.
- Teaching experience had no effect in Shoulders & Myers (2011) research on SoC profile of agriscience teachers

Methods

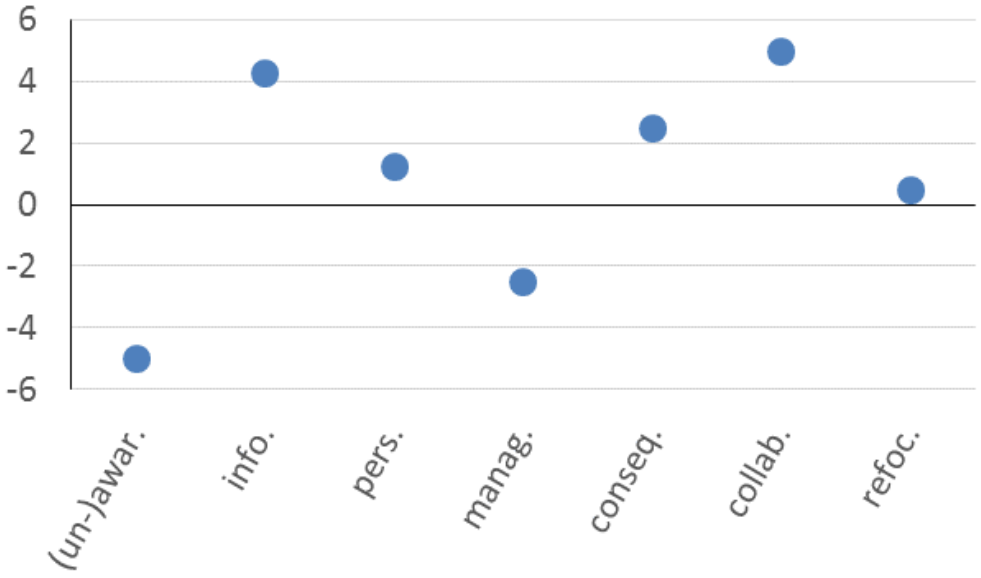
- We studied 52 teachers from 10 countries using Concerns-Based Adoption Model and open-ended questions
- Teachers built teaching modules about Responsible Research and Innovation with the help of experts
- Teachers took 20 minutes to answer an online SoC-questionnaire (33 items) and open-ended questions in their first and last meetings
- Most partners decided to translate the questionnaire

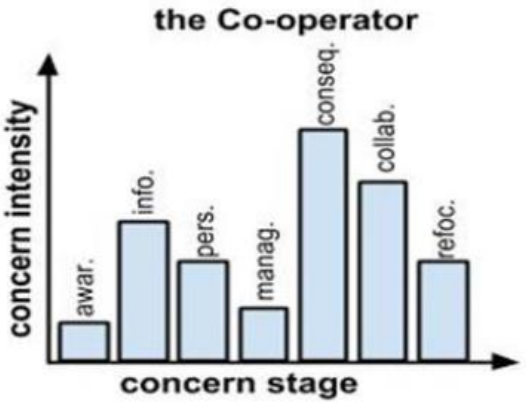
Results



The overall pre-test profile is closest to the Co-operator type
Standard deviations were very high

Results





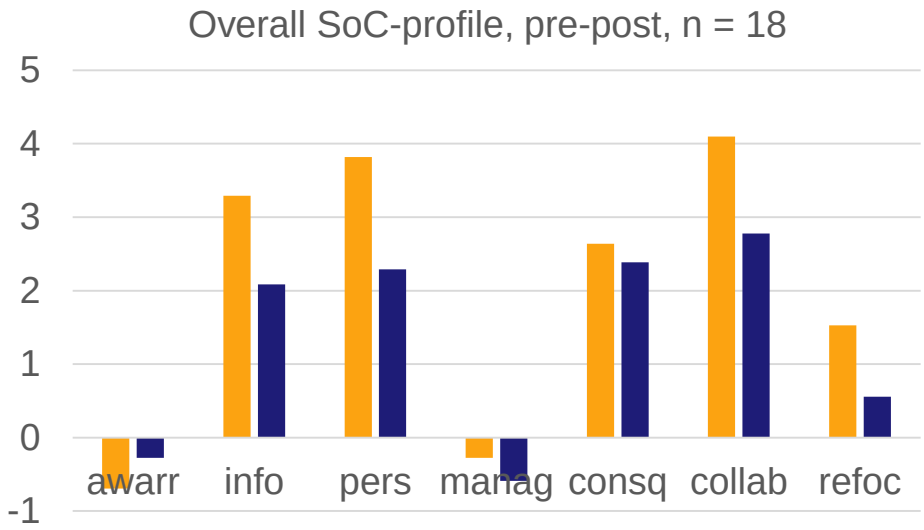
An example of a co-operator profile type found in our study; 14/52 were Co-operators and 22/52 had almost a similar type (info ←→pers). There were no other statistically significant groups.

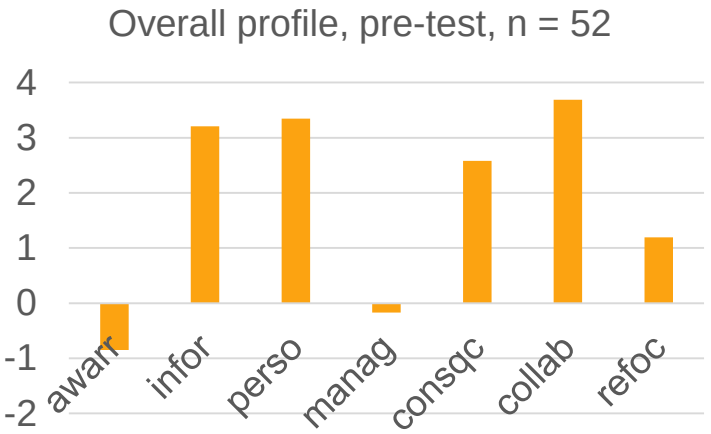
Results: open-ended questions

Expectations from the project

Development of teaching (n=24)	*Development of content knowledge (n=8)*	*Collaborative aspects (n=6)*	*Student engagement (n=7)*	*Promoting themes of the project (n=6)*	*Personal preferences (n=34)*
• Professional development • Growing as a teacher • Effective teaching (n=13)	• Development of content knowledge • New content for teachers and students (n=6)	• Collaborating and contacting with other teachers, teamwork (n=3)	• Engaging and motivating students • Attracting students interest in science • Developing students' competency (n=5)	• Increased awareness • Educating future citizens • Integrating all the projects components into the module (n=4)	• Personal challenge • Interested in new things • Contribution to module development (n=32)
• Learning new and innovative teaching methods • New practice in class (n=7)	• Exploring nano-science, a difficult subject (n=2)	• Practice exchange with European teachers about Responsible Research and Innovation (n=2)	• Designing specific topics that are interesting for students (n=2)	• Learning new and cutting edge science (n=2)	
• Learning to build interactive exhibits • Nice module for schools (n=4)		• Motivating other teachers (n=1)			

Results





- Informational, personal, collaboration and refocusing concerns and interests have decreased slightly.
- Pre-test values are very similar to the whole group of 52 teachers
- However, there are some statistical concerns

Results: Was the change significant?

The change in informational, personal and refocusing stages is <u>almost</u> significant.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of aware is the same across categories of phase.	Independent-Samples Mann-Whitney U Test	,673[1]	Retain the null hypothesis.
2	The distribution of info is the same across categories of phase.	Independent-Samples Mann-Whitney U Test	,091[1]	Retain the null hypothesis.
3	The distribution of pers is the same across categories of phase.	Independent-Samples Mann-Whitney U Test	,091[1]	Retain the null hypothesis.
4	The distribution of manag is the same across categories of phase.	Independent-Samples Mann-Whitney U Test	,767[1]	Retain the null hypothesis.
5	The distribution of consq is the same across categories of phase.	Independent-Samples Mann-Whitney U Test	,673[1]	Retain the null hypothesis.
6	The distribution of collab is the same across categories of phase.	Independent-Samples Mann-Whitney U Test	,152[1]	Retain the null hypothesis.
7	The distribution of refoc is the same across categories of phase.	Independent-Samples Mann-Whitney U Test	,068[1]	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1]Exact significance is displayed for this test.

Results: Respondents who changed their opinion

5. I have a limited knowledge of RRI.

(-2 = disagree, -1 = rather disagree, 0 = I cannot say, 1 = rather agree, 2 = agree)

		pre-test				
		-2	-1	0	1	2
post-test	-2	1	3	1	**2**	**1**
	-1	0	3	0	**3**	**1**
	0	0	0	0	0	0
	1	**0**	**1**	0	2	0
	2	**0**	**0**	0	0	0

		pre-test				
		-2	-1	0	1	2
post-test	-2	1	2	0	**0**	**1**
	-1	2	2	1	**1**	**0**
	0	0	0	0	0	0
	1	**1**	**3**	1	0	0
	2	**1**	**0**	0	1	1

33. I have learned enough about RRI in my teacher education.

Results: personal and management concerns

7. I am concerned about the need to revise my teaching.

		pre-test				
		-2	-1	0	1	2
post-test	-2	2	1	0	**1**	**0**
	-1	2	2	0	**4**	**1**
	0	0	1	0	0	0
	1	**0**	**0**	1	2	0
	2	**0**	**0**	0	0	1

- Similar reaction to item 13: I am concerned about my ability to manage all that teaching about RRI requires.

Results: interests towards RRI teaching

22. I would like to know what teaching about RRI will require in the immediate future.

		pre-test				
		-2	-1	0	1	2
post-test	-2	0	0	0	**0**	**1**
	-1	0	0	0	**2**	**0**
	0	0	0	0	0	0
	1	**0**	**0**	0	4	1
	2	**0**	**0**	0	1	9

Results

Agreement with the following items decreased slightly…

- 24. I would like to have more information on time and energy commitments required by teaching about RRI.
- 10. I would like to discuss the possibility of teaching about RRI.
- 16. I would like to revise the approach of teaching about RRI.
- 19. I don’t spend much time thinking of teaching about RRI
- 25. I would like to determine how to develop the approach of teaching about RRI.

Collaboration interests have also decreased slightly

- 23. I would like to co-ordinate my efforts with others to maximize the effects of teaching about RRI.

Conclusions

- Before the IRRESISTIBLE project teachers had a concern profile of a co-operator (high informational and collaboration concerns). This was also confirmed by the open-ended questions.
- The effect of the project seems subtle, but directions of the changes are coherent
  - Personal and management concerns have been resolved to some extent, collaboration concerns and interest towards RRI teaching decreased with some of the respondents

Conclusions

- Teachers have a need for collaboration and they want to learn and develop themselves as teachers.
- Teachers are interests in acquiring new knowledge, networking with their colleagues, and giving their students positive experiences about science
- We must support teachers interests and try to find ways for long lasting effects of a PD program.

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Leibniz-Institut für die Pädagogik der Naturwissenschaften und Mathematik

The Student Curated Exhibition – a New Approach to Getting in Touch with Science

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irresistible

EXPOneer

FCI
FONDS DER CHEMISCHEN INDUSTRIE

Exhibitions in IRRESISTIBLE

6E model

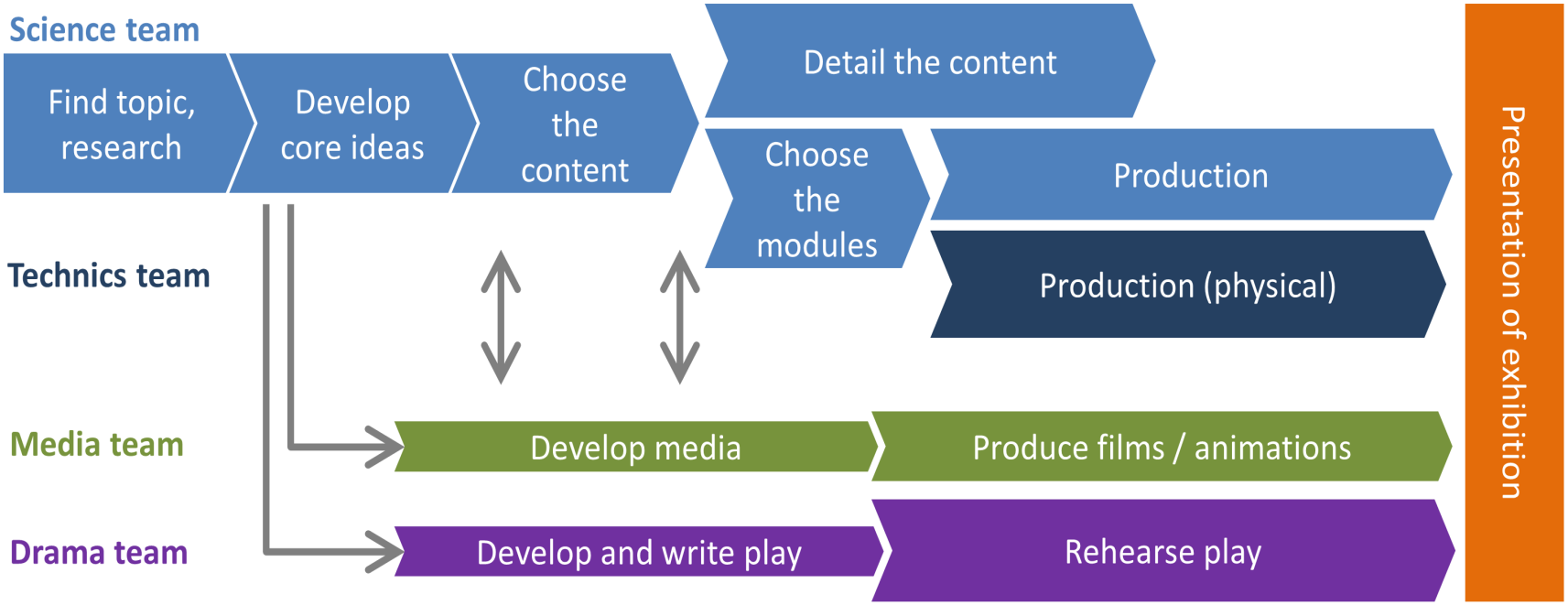
Exchange

→ The students build an **exhibit/ poster** in which they demonstrate the RRI issues they have identified. The exhibits are the collected in the science center and displayed there. The exhibits can be judged, so the best exhibits may receive a prize.

→ Every class builds one (interactive) exhibit!

Core Idea of EXPOneer

- Learning chemistry (physics/ biology/ RRI/ …) by doing those things you like to do?

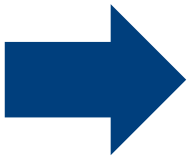


Exhibitions at School

- Usually poster exhibits…

Exhibition System

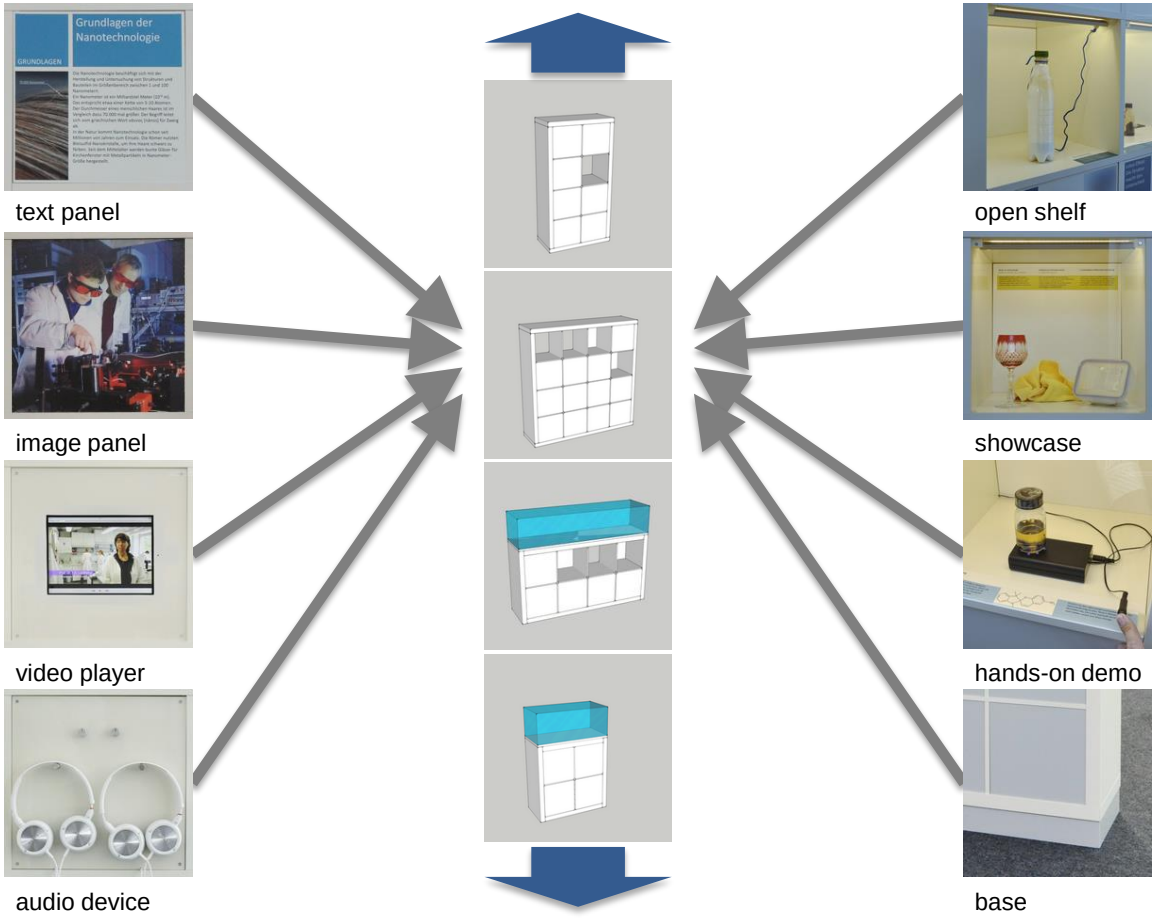
- modular system
- highly flexible
- quick & easy to build (at school)
- open access
- low priced



IKEA

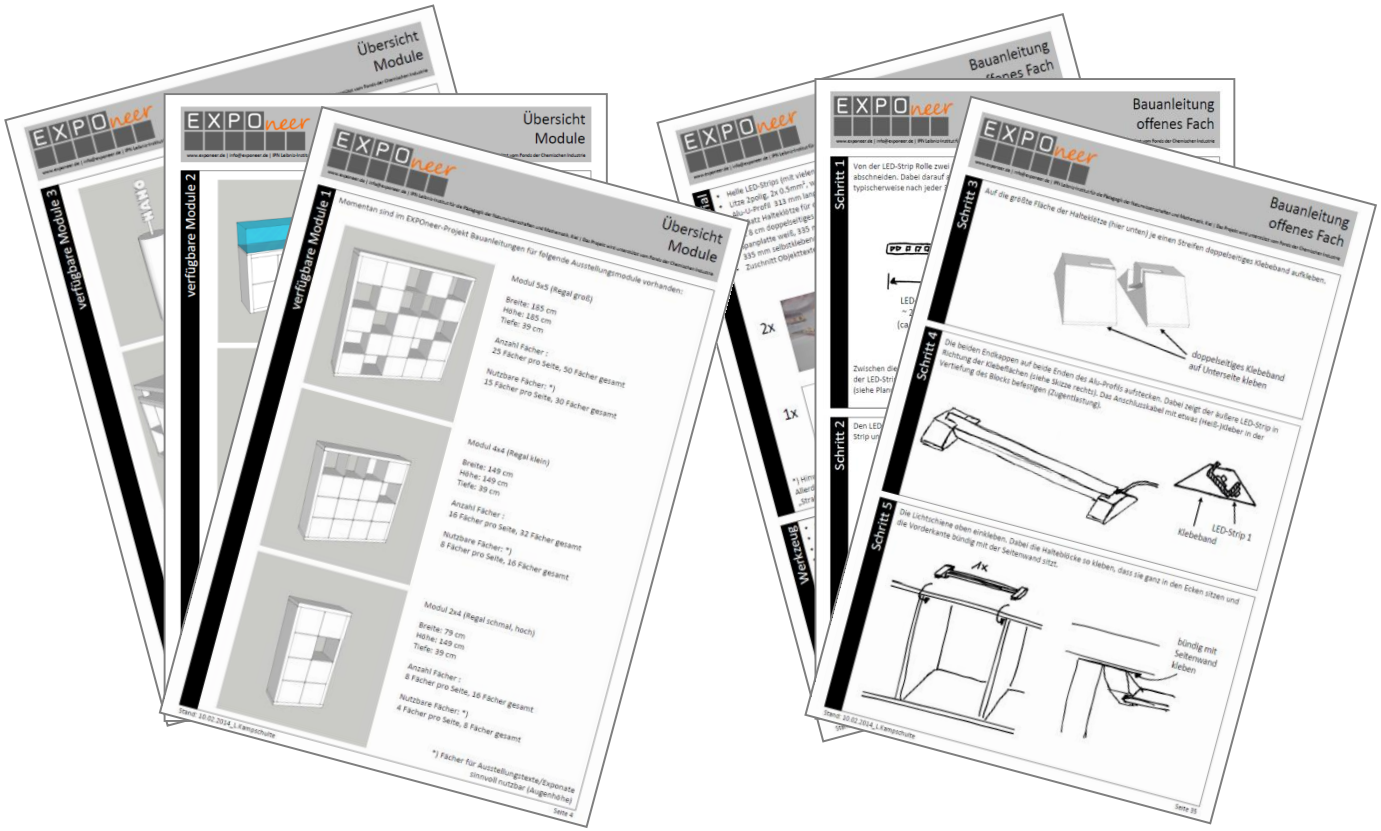
EXPOneer Functional Elements

Modular system with standardized elements



EXPOneer Functional Elements

Guide: How to build an exhibition

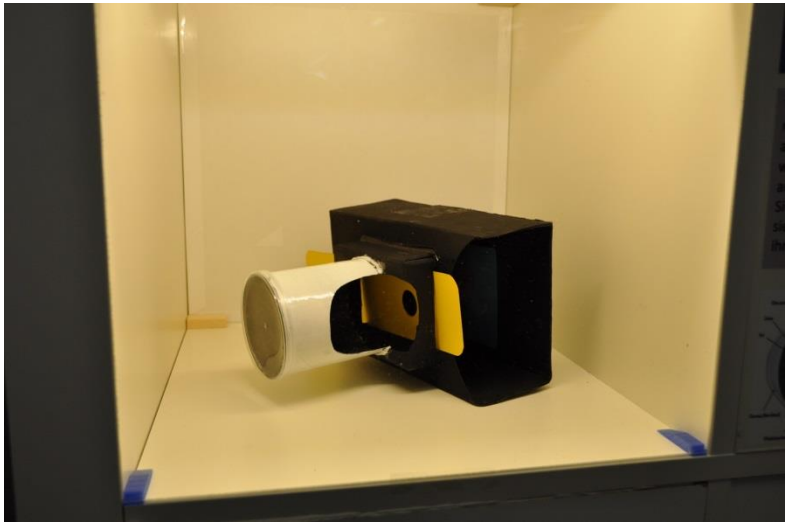


Project “Pictures of Me”

- High school (Gymnasium) Heikendorf

Project “Pictures of Me”

- High school (Gymnasium) Heikendorf

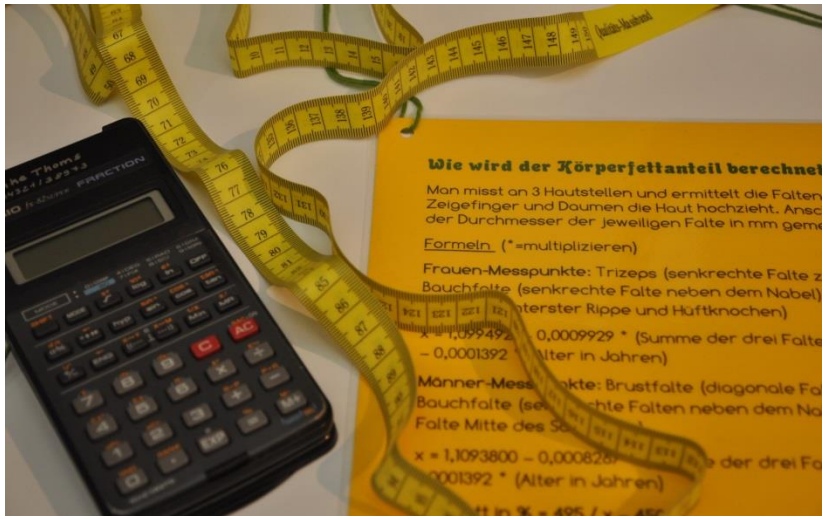


Project “Fat!”

- High school (Gymnasium) Eckernförde

Project “Fat!”

- High school (Gymnasium) Eckernförde



Project “Nanoreseach in Kiel”

- University outreach project, shopping mall Kiel

Project “Nanoreseach in Kiel”

- University outreach project, shopping mall Kiel

Project “Fat!”

- high school, grade 10/11
- joint project chemistry and art course

Evaluation tool

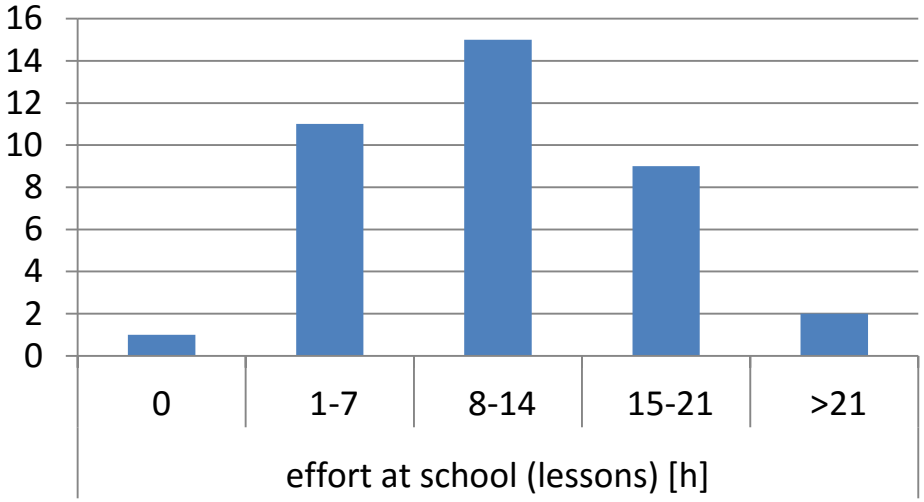
Questionnaire

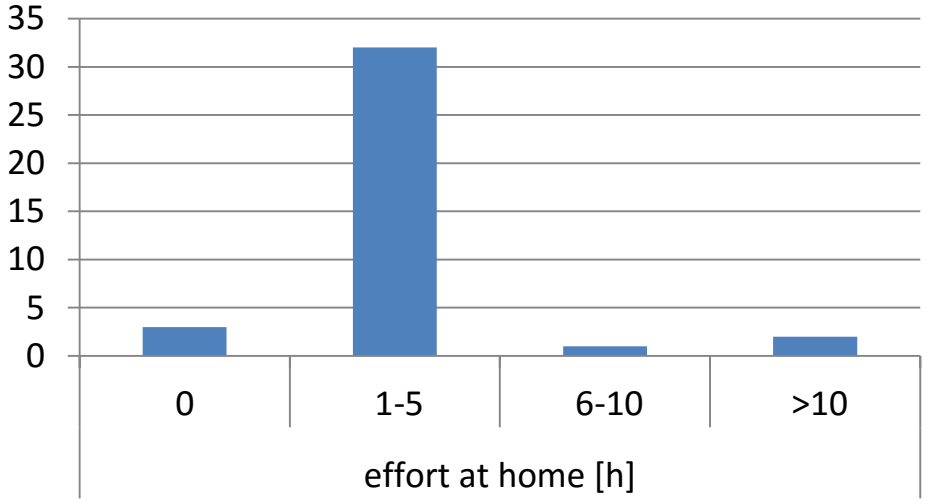
Reliabilities	pre	post
expert knowledge	.77	.85
motivation	.76	.72
social learning	.82	.85
autonomous work	.71	.90
exhibition development	.79	.82
authenticity	.76	.87
everyday context	.61	.72
scientific working	.39	.79

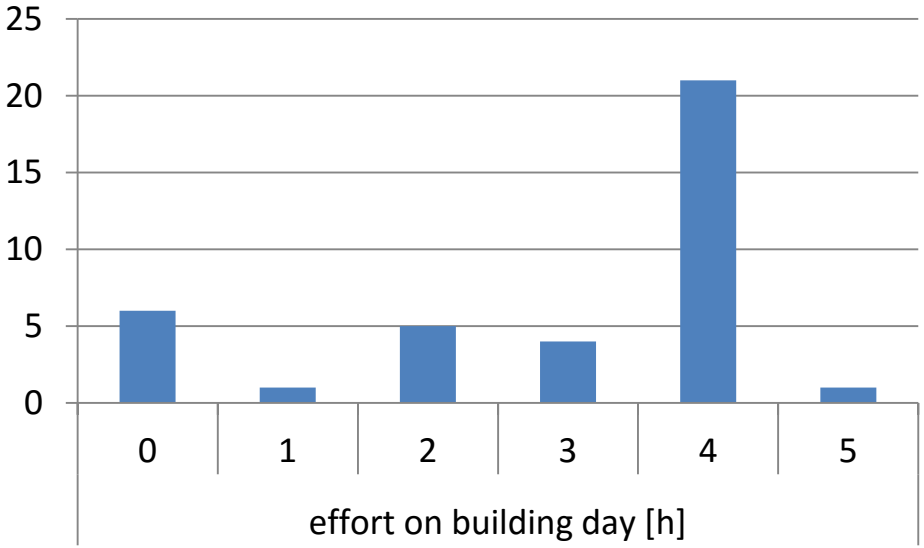
N = 46

Evaluation exhibition “fat!”

Time necessary to develop and build the exhibition



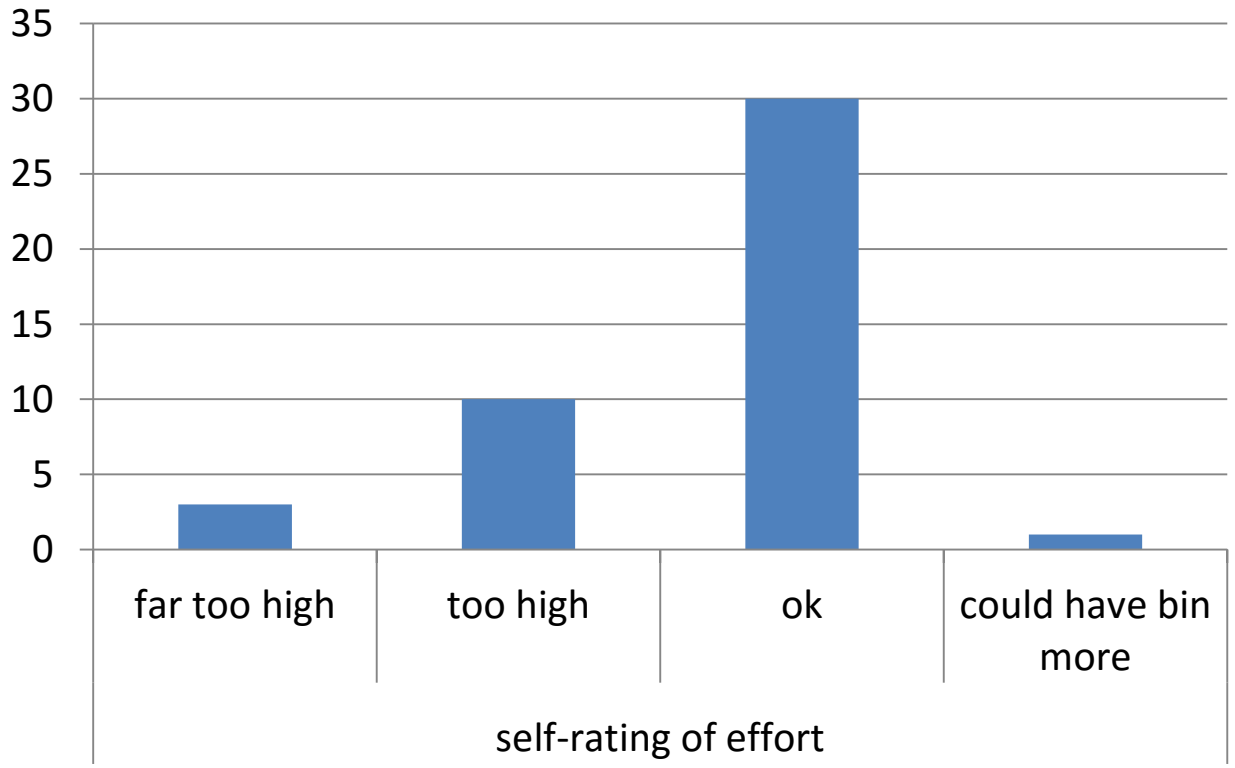




N = 38
Total student hours in project: 514 h
Average: 13.5 h / student

Evaluation exhibition “fat!”

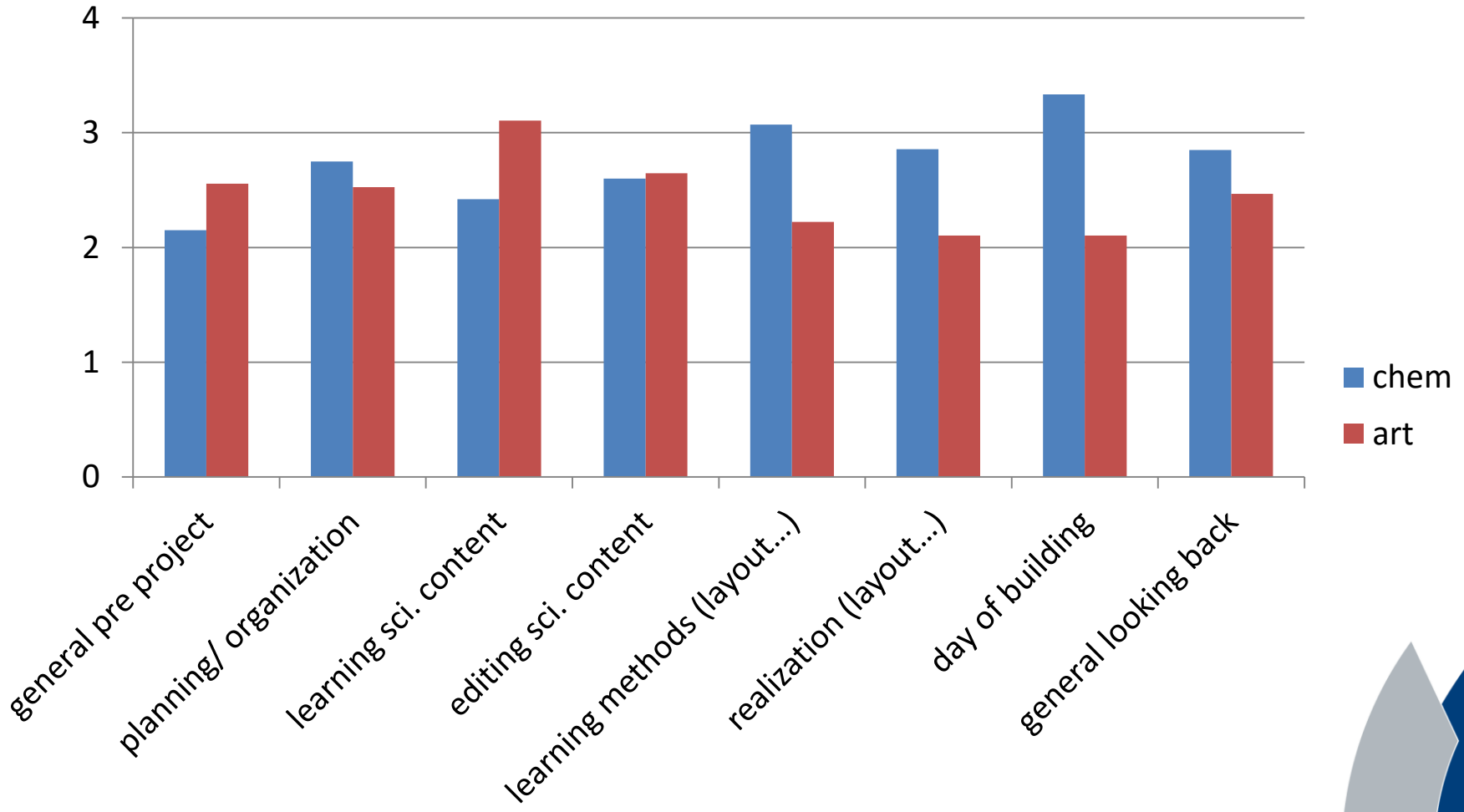
“How do you rate the effort necessary for the project?”



N = 44

Evaluation exhibition “fat!”

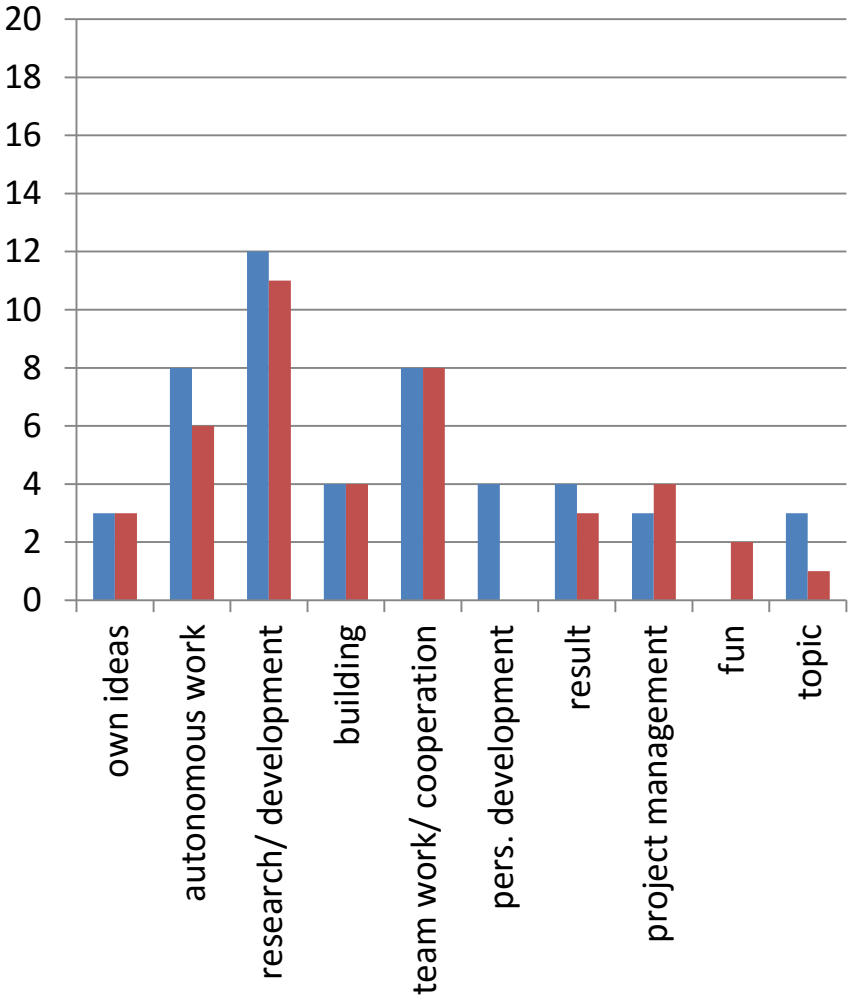
Motivation: Chemistry vs. Art course



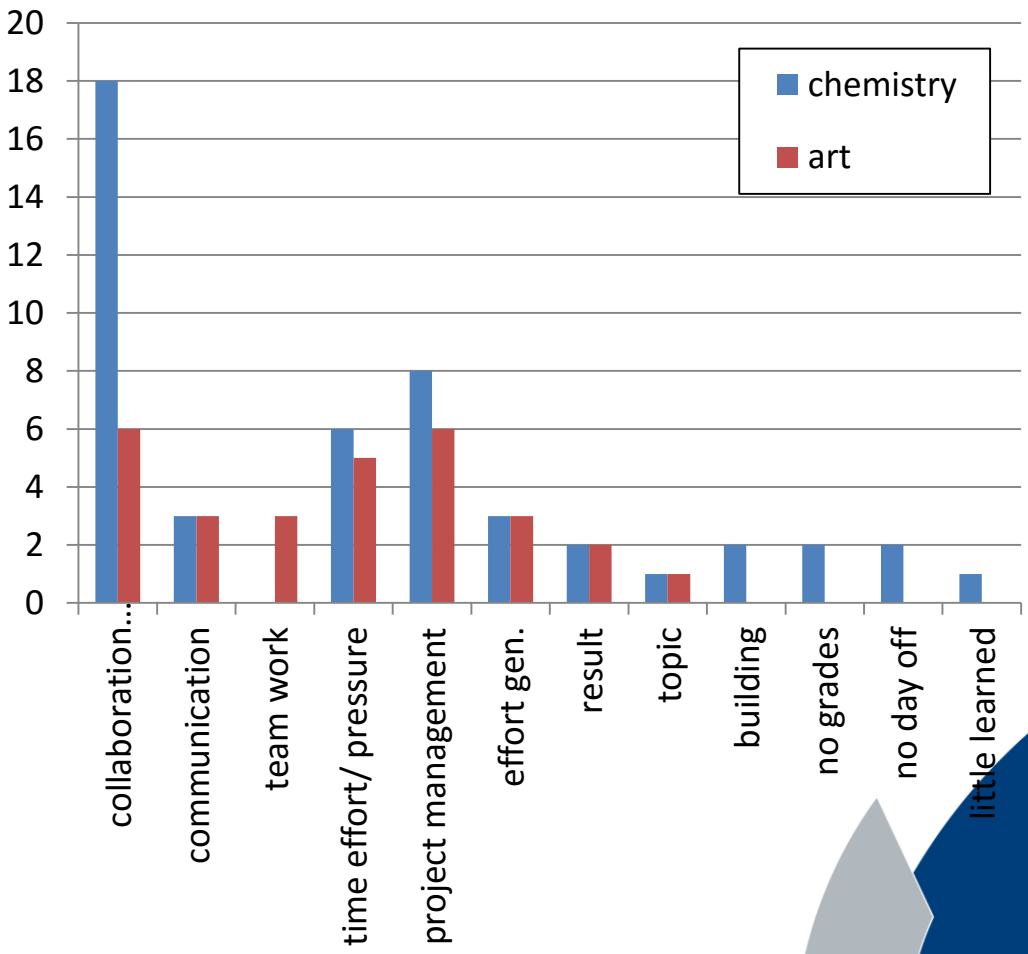
Likert 1…4; N = 39

Evaluation exhibition “fat!”

“What did you like?”



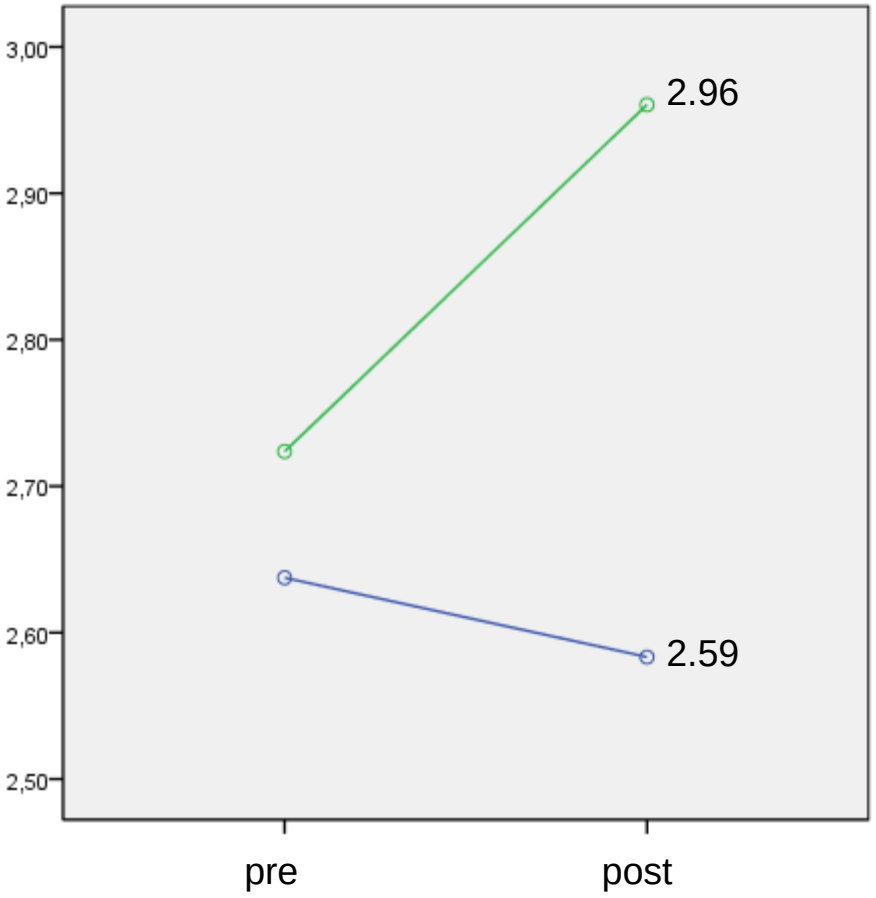
“What did you not like?”



free text item, 3 answers possible, N = 44

Evaluation exhibition “fat!”

exhibition development



“…learn about the descriptive explanation of sci. knowledge...”
“…learn about the development of exhibitions…”
“…experience building exhibitions…”
…

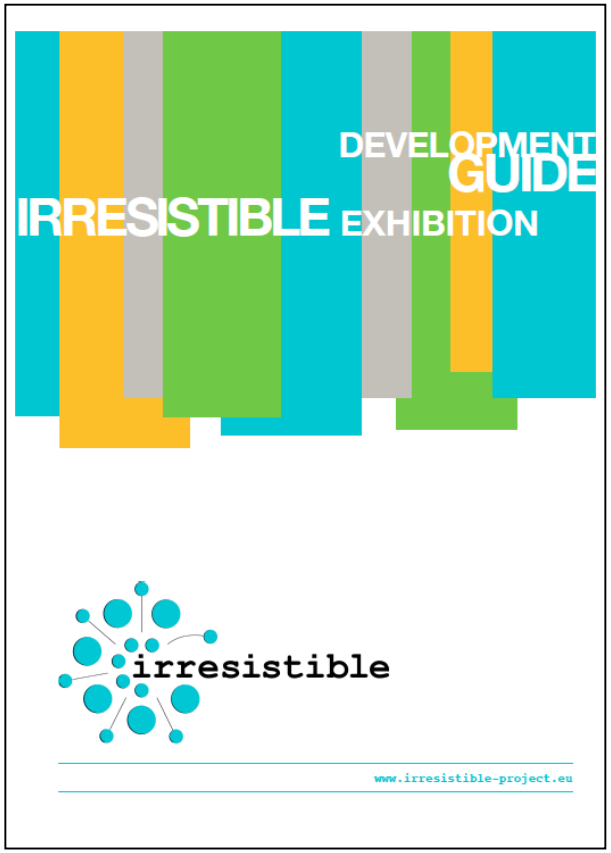
[time n.s.; time*course n.s.]

● = art course, ● = chemistry course; Likert 1…4; N = 40

Lessons learned

- limited time frame at school needs good project management
- good cooperation between the stakeholders (teacher/ classes/ …) is essential for the project outcome (timing, curricula, communication…)
- to build a mid-sized exhibition in one day is easily possible (two classes / ~ 40 students)

IRRESISTIBLE project



Exhibition Development Guide

IRRESISTIBLE WP3

Pedro Reis

Universidade de Lisboa

Thanks to…

Ilka Parchmann

Stefan Schwarzer

Frederike Tirre, Bente Hansen

The Chemical Industry Fund

Get started and EXPOneer!

Lorenz Kampschulte, kampschulte@ipn.uni-kiel.de → www.exponeer.de

RRI and Nanotechnology: Developing a Teaching Module and Exhibits for Primary and Secondary Students

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[2]Department of Primary Education, University of Crete, Greece

Introduction

Current literature indicates the need Science Education to render compatible with the latest scientific advances and social demands, to enhance students' interest in science and technology and to promote inquiry-based learning by familiarizing students with scientific methods and the communication of science (Osborne,2008). Nanoscience and Nanotechnology set up a scientific field appropriate to attain these objectives as they can initiate students to processes and nature of science and assist their moral and ethical development (Sadler, 2004; Jones et al. 2013). However, as teachers' quality is the most important factor influencing student achievement (Darling-Hammond, 2000), there is still a need for teacher training in cutting-edge science topics and for novel means of students' communication of their acquired knowledge.

Objectives

To this end, in the context of the IRRESISTIBLE project in Greece, primary and secondary school teachers supported by scientists, science education and science museum experts, developed and implemented a teaching module on Responsible Research and Innovation (RRI, European Commission 2012) using topics from the field of NST. The final outcome of the module was the construction of exhibits by the students to communicate the new knowledge to the wider public.

In the present study we investigate:

a) Teachers' abilities and difficulties in reconstructing the new scientific area of nanoscience and nanotechnology focused on RRI aspects into content for instruction

b) Primary and secondary school students' abilities and difficulties to construct exhibits on RRI aspects based on NST topics to communicate the knowledge acquired.

Methodology

Development and Implementation of the module

Five highly qualified and experienced in-service teachers (one primary teacher, two physics teachers and two chemistry teachers) participated as active members in a Community of Learners (fig.1)

Since the members of the CoL are located in different parts of Greece, teleconferences and face to face workshops were used in order to facilitate the collaboration and exchange of ideas and materials.

The development of the module was completed through a process 12 months long, as described in Fig.2

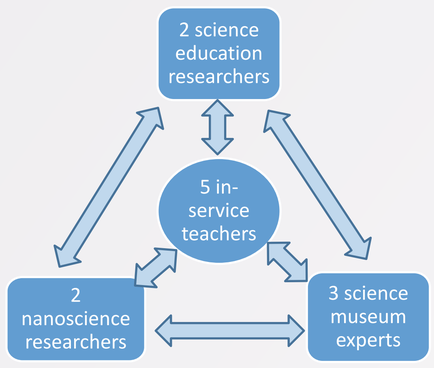

Fig.1 The greek CoL

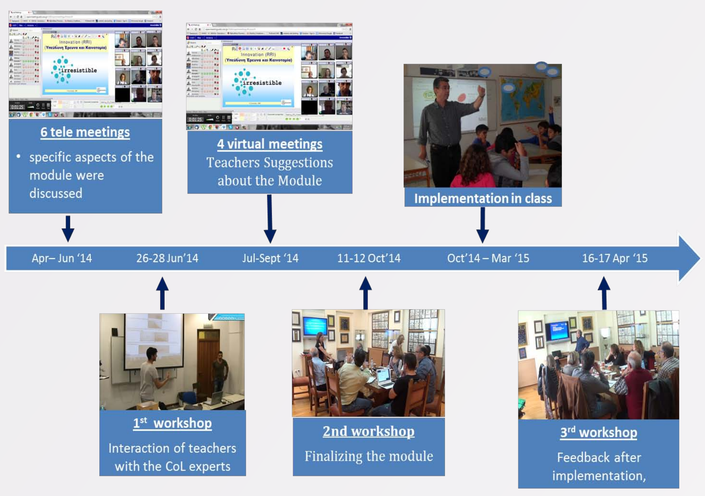

Fig.2 Module development timeline

Structure of the module

Lesson 1. Introduction
Lesson 2. Visiting the Science Museum
Lessons 3 & 4. Nanoscience Applications: Self-Cleaning Materials
- How small is Nano?
- Size-dependent properties

Lesson 5. RRI-Issues
- Newspaper articles
- Discussion with experts in school and the research center

Lesson 6. Visiting the Research Center
Lesson 7. Construction of Exhibits

Exhibits Development

During the exhibits development, students were supported by science museum experts (E.F.), science education researchers (UOC) and their teachers as shown in fig.3

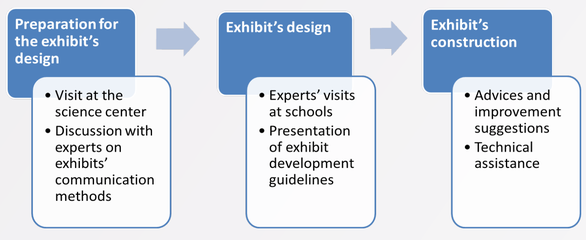

Fig.3 Support provided during each exhibit development phase

Examples of students' exhibits

Data collection

On Module development	On exhibits development
Pre- and post- teachers training questionnaire (NST and RRI)	Pre- and post exhibits development questionnaire
Questionnaire on module development suggestions (teachers)	Semi constructed focus group interviews
Video-recordings of the CoL meetings	Field notes
Semi constructed individual interviews (teachers)	Students' exhibits
Developed modules at different phases of teachers training	Individual interviews (teachers)

Table1. Data collection methods we used

Results

Development and Implementation of the module

As far as it concerns the teachers, they take advantage of experts' participation in CoL, developing a module intergrating nodal NST and RRI issues that brings in balance formal and informal education features.

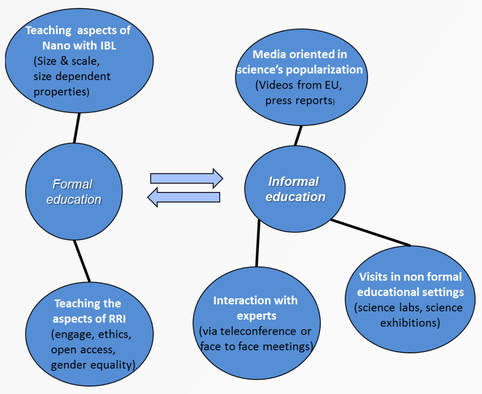

Fig.4 Aspects of formal & informal education in interaction

Exhibits Development

Students managed to develop several types of scientific exhibits addressing a wide range of NST aspects (Table2 & Table3).

Exhibits scientific content	Primary education	Lower secondary education	Upper secondary education	Total
SyperHydrophobic materials/ size dependent properties	1	1	1	**3**
Nano-medicine		2	1	**3**
Other nano-applications (ferrofluids, photocatalytic materials)		1	1	**2**
Size and scale	3			**3**
General nanotechnology knowledge	3	1		**4**
Nanostructures			1	**1**

Table2. Exhibits' scientific content

Exhibits type	Primary education	Lower secondary education	Upper secondary education	Total
Interactive posters	3	2	-	**5**
Informative posters	1	1	2	**4**
Playful activities (Board games, origami crafts etc.)	2	-	1	**3**
Digital/multimedia exhibits (digital interactive posters, digital game, quiz, video)	-	2	4	**6**
Experiments activities	1	1	2	**4**

Table3. Exhibits' Type

During the exhibit development process students are influenced by several factors both in the selection of the content and the type of the exhibit. The main factors are shown below in fig.5. Finally, in terms of RRI aspects presentation, students seem to face difficulty in integrating all RRI aspects in their exhibits and giving an overview of what comprises RRI as they focused mostly in science education (Table4).

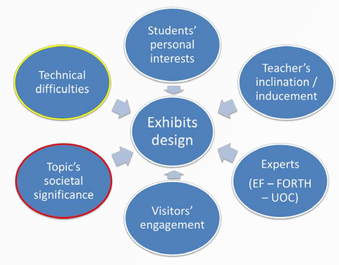

Fig.5 Factors that influenced students in exhibits development

RRI Aspects	Primary education	Lower secondary education	Upper secondary education	Total
Engagement	1	2	3	6
Science Education	6	5	4	15
Gender	_	2	1	3
Ethics	-	3	1	4
Open Access	-	3	1	4
Governance	-	2	-	2

Table4. RRI aspects presented in exhibits

Conclusion

Implementing the IRRESISTIBLE Project, teachers combine formal and informal learning tools for teaching RRI aspects through NST topics. The effectiveness of such a combination can be seen from the students gained ability to communicate the acquired knowledge by designing science exhibits .

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IRRESISTIBLE is a project on teacher training, combining formal and informal learning focused on Responsible Research and Innovation.

It is a coordination and support action under FP7-SCIENCE-IN-SOCIETY-2013-1, ACTIVITY 5.2.2 Young people and science: Topic SiS.2013.2.2.1-1 Raising youth awareness to Responsible Research and Innovation through Inquiry Based Science Education.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 612367.

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Teacher Training at Chemistry Faculties – Mutual Benefits? A Case Study Based on the Example of the IRRESISTIBLE Project

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[1]Jagiellonian University in Krakow, Poland, [2]University of Groningen, the Netherlands

Teacher education at a Faculty of Science or at a Faculty of Pedagogy? – the Jagiellonian University case

1917/18 - chemistry teacher education established at the Faculty of Philosophy ; teachers well educated in pedagogy and psychology, less in science

1972 - teacher education moved to the Faculty of Chemistry; future teachers obtain Master in Chemistry, additional qualifications for chemistry students, cooperation between the Faculty and secondary schools,

Partners Institutions

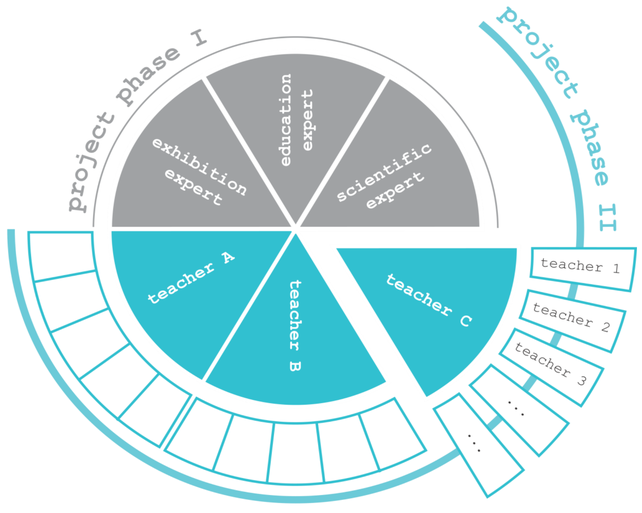
IRRESISTIBLE

EU FP7 Project 2013-2016

The goal of the project is to design activities that foster the **involvement of students and the public** in the process of **Responsible Research and Innovation** (RRI) by using formal (school) and **informal (**science center, museum or festival) **education.** In each of the ten partner countries a Community of Learners will develop **a thematic module. IBSE** approach in the form of 5(6)E will be recommended.

http://www.irresistible-project.eu

Comunity of Learners



Evaluation questionnaire was prepared based on the PMI(Q) evaluation too: *Plus, Minus, Interesting (Questions)* developed by Edward de Bono. To the original questions the following expressions were added: difficult/easy, known/unknown. All CoI members completed that questionnaire.

Semi-structured interviews with some CoI members - scientists imployed by JU (also academic teachers) were conducted: A1 –Associate Professor, 25 years of experience in academic work/university teaching; A2 –Associate Professor, 10 years; A3 –Full Professor, 28 years. According to the results of the interviews – the scientists had no prior significant contact with schools, and the contact was limited to that through their own children (A1, A3), upper secondary school graduates beginning their studies at JU (A1, A2), occasional lectures/workshops for teachers (A1, A3) or students (A1, A3), family talks (A3).

As a result of cooperation with school teachers, some lecturers realized **how important it is to adapt the language and content of the message to the recipient…**

„It is a different world, every time you need to think about what and how you want to convey, whether you are you sure that the message will get to the other person (a teacher or a student) and it will be understood „ (A2)

The participation in workshops with teachers was **inspiring in terms of teaching methods…**

*„I can see that the **active methods** have their advantages and I will try to use them during my classes" (A1)*

*„RRI or that **6E** rule are very general things, and they fit everywhere, no matter what level of education you deal with." (A3)*

*„Young people have changed a lot; I still remember what our chemistry clubs looked like (...) we did not work as a team at all, (...) and I really like that [**students' group work**], as well as focusing on [student] **projects**, which, incidentally, are also missing when studying at universities, (...) and they should be the basis of learning, because then when we construct research teams they need to be interdisciplinary; people must cooperate." (A3)*

Scientists realized **how much they may help education**:

*„I realized that the interaction with teachers is significant; they asked a **whole bunch of questions**, both formal and informal ones, and it reached its apogee when we met in [research] labs with their students' (A3)*

*"Teachers were saying many times that they needed from us sometimes some very **specific knowledge**, for example we say "active sites", but to make it clear to them what an active site is... to make them able to tell young people whether it is a single atom or a group of atoms*?" (A3)

The contact with students and teachers delivered **new knowledge about school, which will be possible to be used in university education.**

*„When implementing the project, we talked much about **the chemistry curriculum in schools** (...) now we will have the graduates who had a different curriculum [than the previous ones] followed; I learned more about what they [students – upper secondary school graduates] **know and what they don't know**; I need to take that into account when doing my course [for 1st year university students] „(A1)*

*„Students are the same everywhere – if there is something that makes them interested, they will be encouraged [to learn], but even if there is something interesting (from the perspective of a scientist) but not "sold" well, students will not be interested. **It is not enough to have an interesting and useful topic; we need to have it "well-packaged".**'"(A2)*

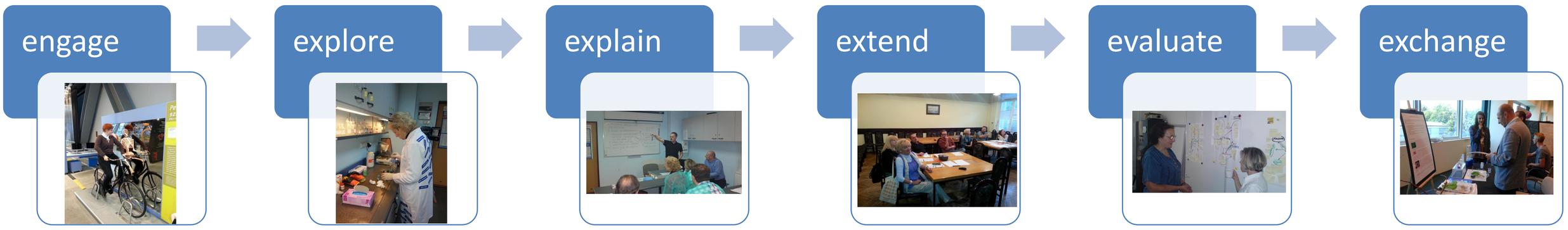
Other remarks:

*„As a result of the CoL monthly meetings (...) when I do research now, I think about **RRI; we incorporate it into our discussions in the research team**" (A2).*

*„I wish that contact [with schools] was better in the future, because it seems to me that there are **two separate worlds – "school" and "university"** – and a "band gap" between the two levels. If we managed to combine the two, it would be for the benefit of everyone." (A3)*

*„Meetings with students also made me realize **how we, as the scientific community, are isolated from the society**. They pass on what they heard somewhere from older mates or parents, and that [the image of a scientist] was surprising. (A3)*

6E structure of IBSE activities (also during CoI meetings)



This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 612367. It is a coordination and support action under FP7-SCIENCE-IN-SOCIETY-2013-1, ACTIVITY 5.2.2 Young people and science: Topic SiS.2013.2.2.1-1 Raising youth awareness to Responsible Research and Innovation through Inquiry Based Science Education.

Integrating Responsible Research and Innovation to Nanoscience Applications as Extracurricular Activity in Secondary Science Education

Sevil Akaygun | Emine Adadan | Amitav Sanyal | Busra Acikel

Introduction

Responsible Research and Innovation (RRI) is defined as 'a transparent, interactive process by which societal actors and innovators become mutually responsive to each other' (Von Schomberg, 2013). As RRI has becoming an integral part of science and technology, the need for understanding RRI and its key components by the society is rapidly increasing. One attempt to meet this need is to incorporate RRI into K-12 science education. To this end, a cutting edge science, nanoscience and its practical applications has been selected, and a RRI-integrated nanoscience module has been developed. This particular module was implemented as an extracurricular activity. The module included several inquiry-based activities, focusing on six key aspects of RRI; engagement, governance, gender equality, science education, open access, and ethics, in the context of nanoscience applications.

Settings of the Study

- The RRI-integrated nanoscience module was developed by a group of experts composed of science teachers, science educators, scientists, and museum experts, the so called Community of Learners (CoL).
- The content of the module was prepared in an inquiry-based format by integrating the 6E approach, i.e. engage, explore, explain, elaborate, evaluate and exchange, in various tasks and activities. The key aspects of RRI were integrated in specific tasks where the students analyzed and discussed the given scenario.
- Students learn the fundamental concepts of nanoscience, such as nanometer, size and scale, nanoparticle, antibacterial effect, as well as the key aspects of RRI such as engagement, while discussing why the committee included members from different societal actors.
- The module has been implemented to middle and high school students for 8 weeks, spending 11 contact hours in total. Then, students spent 3 weeks developing an exhibition on nanoscience applications integrating RRI.
- The lesson topics of the module are:
  - Hospital-Acquired Infections
  - Size and Scale
  - Modeling Drug Release or Absorption
  - Imaging Bacteria
  - Synthesizing AgNP and Testing Its Antibacterial Effect
  - Antibacterial Effect of Nanoproducts
  - Other Nanoparticles
  - Responsible Research and Innovation
  - Designing an Interactive Exhibition Product

Data Collection and Analysis

Design of the Study: A mixed methods design was adopted in the study and both quantitative and qualitativedata were collected.

Participants: In the study, participants were selected by purposeful sampling, because the module was implemented to the students whose teachers were a part of the CoL. The teachers of five different schools were recruited to work in the CoL through convenience sampling, considering their previous experience in nanoscience education.

Instruments & Data Collection:

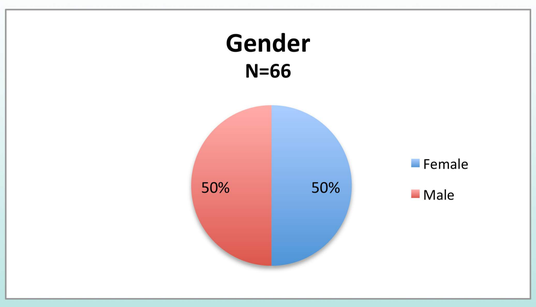
- For the quantitative aspect, students were given Nanoscience Content Questionnaire, Nanoscience Awareness Questionnaires, and Responsible Research and Innovation Questionnaire before and after they engaged in the module. The Nanoscience Content Questionnaire was composed of open-ended questions related to fundamental concepts of nanoscience. The other two questionnaires were of Likert-type.
- Qualitatively, selected students were interviewed in a semi-structured format in the beginning and at the end of the module. Additional data sources, including student created artifacts, teachers' observations, and field notes, were also collected.

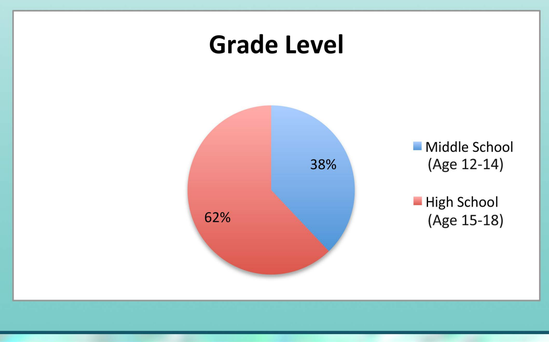
Data Analysis:

- For the quantitative data, the mean scores are compared statistically by Wilcoxon Signed Rank Test, for each participating school, and the whole group of participants. For the qualitative data, semi-structured interviews are coded by open coding. Results of the qualitative analysis are not reported in this paper. The emerging categories are determined and the resulting categories are explained in more detail.
- Similarly, students' artifacts and teachers' field notes will be coded and analyzed to investigate further effects of an RRI-integrated nanoscience module on students' attitudes towards RRI, conceptual understanding and awareness of nanoscience, to support quantitative data.

Findings

Demographics





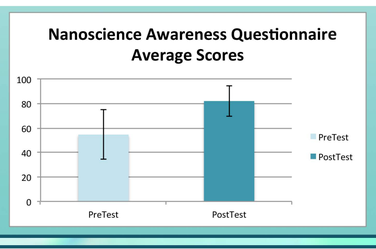
Nanoscience Awareness Questionnaire

Descriptive Statistics				Test Statistics[a]	
	N	Mean	Std. Deviation	Z	Asymp. Sig. (2-tailed)
PreTest	63	54.6032	20.32045	-6.580[b]	.000
PostTest	63	82.0317	12.39793		

a. Wilcoxon Signed Ranks Test b. Based on Negative Ranks

Wilcoxon Signed Rank Test				
Ranks				
		N	Mean Rank	Sum of Ranks
Post Test- Pre Test	Negative Ranks	1[a]	29.50	29.50
	Positive Ranks	60[b]	31.03	1861.50
	Ties	2[c]		
	Total	63		

a. PostTest<PreTest b. PostTest>PreTest c. PostTest=PreTest



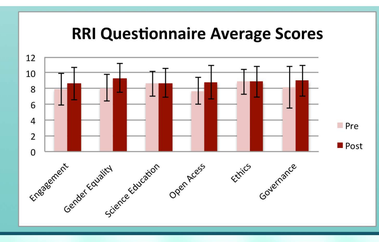
Responsible Research and Innovation Questionnaire

Descriptive Statistics				Test Statistics[a]	
	N	Mean	Std. Deviation	Z	Asymp. Sig. (2-tailed)
PreTest	21	163.5714	22.63531	-2.034[b]	.042
PostTest	21	173.3333	21.44139		

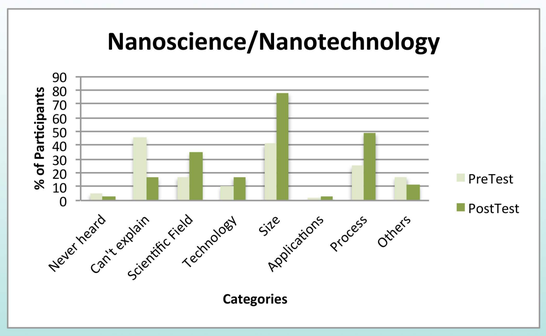
a. Wilcoxon Signed Ranks Test b. Based on Negative Ranks

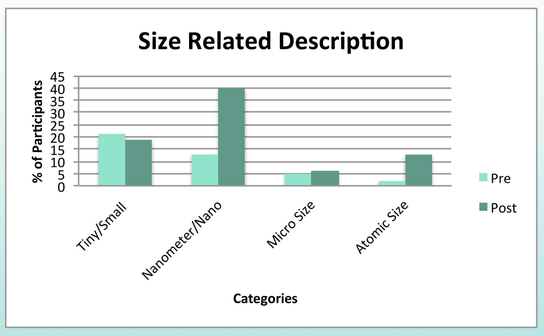
Wilcoxon Signed Rank Test				
Ranks				
		N	Mean Rank	Sum of Ranks
Post Test- Pre Test	Negative Ranks	4[a]	14.25	57.00
	Positive Ranks	17[b]	10.24	174.00
	Ties	0[c]		
	Total	21		

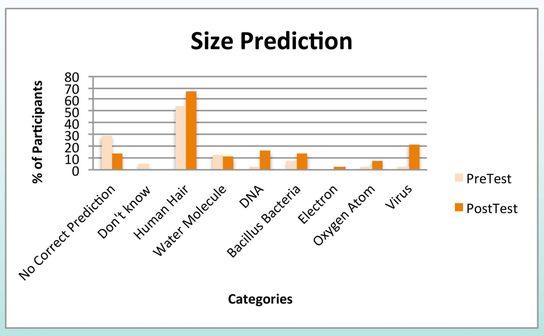
a. PostTest<PreTest b. PostTest>PreTest c. PostTest=PreTest

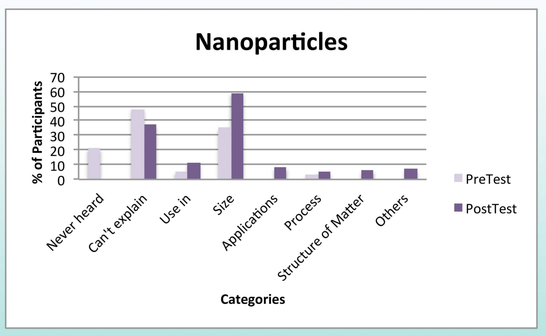


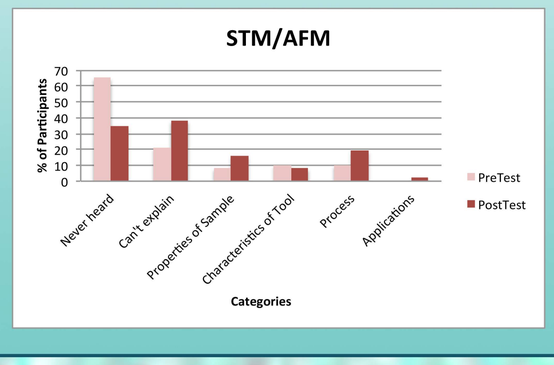
Nanoscience Content Questionnaire

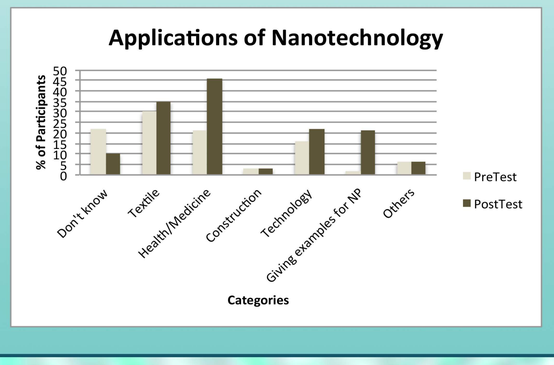


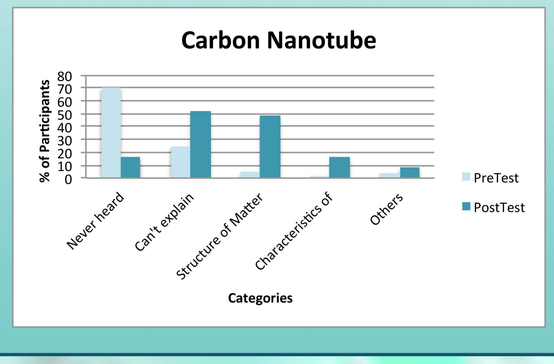


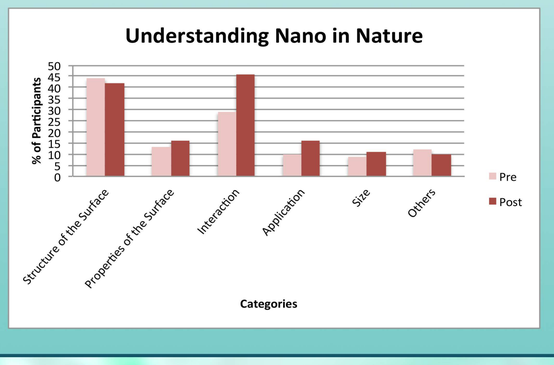












Conclusion and Discussion

- In this study, a Nanotechnology Applications in Health Sciences Module was developed by Community of Learners, and implemented to 65 secondary school students as an extracurricular activity for 12 weeks. When the students' Nanoscience Awareness, Understanding of RRI and Conceptual Understanding of Nanoscience were compared in the beginning and at the end of the implementation, specific improvements we're observed.
- After completing the module, students reached to a significantly higher level of Nanoscience Awareness ($p=0.000$) and Understanding of RRI ($p<0.05$) in total and specifically in the aspects of 'gender' ($p<0.05$) and 'open access' ($p<0.05$). For the conceptual understanding, they started to describe Nanoscience and Nanotechnology by emphasizing sizes, scale and applications. They reached a deeper understanding of nanoscience in nature, nanoparticles and related applications. In conclusion, the module helped students improve their conceptions in Nanoscience as well as Responsible Research and Innovation.
- All in all, the module can be suggested to other secondary students as a good practice.

References:

Von Schomberg, Rene (2013). A vision of responsible innovation. In R. Owen, M. Heintz and J Bessant (eds.) Responsible Innovation. London: John Wiley.

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

IRRESISTIBLE is a project on teacher training, combining formal and informal learning focused on Responsible Research and Innovation.

It is a coordination and support action under FP7-SCIENCE-IN-SOCIETY-2013-1, ACTIVITY 5.2.2 Young people and science: Topic SiS.2013.2.2.1-1 Raising youth awareness to Responsible Research and Innovation through Inquiry Based Science Education.

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http://www.irresistible-turkiye.com/index.html