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

D2.2 programmes: Programme for and record of Community of Learners for leading teachers, including teaching materials and experiences with the different CoL structures in the countries

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Author(s): *Contributions from all partners collated by the WP2 leader Ron Blonder (Weizmann Institute of Science) and Sherman Rosenfeld (Weizmann Institute of Science)*



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1. Executive Summary

The D2.2 report presents the progress of the Irresistible Project's work with the first round of the Community of Learners (CoL) in the 10 participating countries.

1. The meetings of the CoLs have ranged from 10 to 30, with an average of about 16 per country.
2. The modules developed by the partners include topics relating to health, the environment and nanoscience.
3. There were 79 teachers and over 1300 students involved in learning/teaching these modules. There was an overrepresentation of female teachers; the students were evenly divided in terms of gender.
4. The changes in the proposed work of the partners reflect adaptation of the work to local conditions. The changes also reflect the dynamic nature of the CoLs in their authentic process of joint knowledge-building.
5. Challenges faced by the partners in this first CoL round are discussed and proposed solutions are presented.
6. Challenges and proposed solutions to the project's second CoL round.

2. Introduction

The goal of WP-2 is to coordinate the establishment of the teacher training effort for the Irresistible Project, using the Community of Learners (CoL) approach.

At the kickoff meeting Work Package Leader (Weizmann) delivered a workshop in which template for the 5E+ model for IBSE that can be used by the CoL was presented and delivered. In this workshop Work Package Leader (Weizmann) coordinated the planning of the two-phase professional development programme of the partners, by developing a schedule and a plan for the work in the CoLs in the different countries. This stage was reported in the first WP-2 report that was delivered on month 3.

3. Data from the First CoL Round

All the partners established a CoL in their county and started to work on their Irresistible modules. All CoLs include science educators, an informal expert from a science museum, scientists and teachers. The number of the teachers in the CoLs varies from 4 to 15. The total number of teachers that are involved in the first cycle of the Irresistible CoL is 79. It is interesting to note that in the project proposal we planned to recruit over 50 teachers in this stage of the project. The high number of teachers shows that the project is very relevant and attractive for them. In the following 3 tables we will present data regarding the different CoLs. Later we will describe the changes that were made from the primary program and the challenges for the future in WP-2.

Table 1: Meetings of the Different CoLs

Country	Date of 1st CoL Meeting	Number of CoL Meetings
1 The Netherlands	Sep. 2014	10
2 Israel	Dec. 2013	14
3 Germany	Oct. 2014	10
4 Turkey	Jan. 2014	30
5 Portugal	March 2014	20
6 Italy Bologna	April 2014	9

Palermo	April 2014	8
7 Finland	Sep. 2014	12
8 Greece	April 2014	15
9 Poland	April 2014	12
10 Romania	Feb. 2014	10

Table 2: Irresistible Modules in the Different Countries

Country	Module Topic	Module Length (student contact hours)	Module Initiation with students
1 The Netherlands	Carbohydrates in milk; how specific carbohydrates in human milk are beneficial for the development of the gut microbiota of babies, and how these are produced in industry for use in milk powder	About 12	March 2015
2 Israel	Photovoltaic cells and Perovskite	About 16	Jan. 2015
3 Germany	Oceanography Sub-topics: Plastics in our ocean, ocean acidification, resources of the ocean (for example manganese nodules), the problem of overfishing, offshore windparcs	Every sub module: 5 to 15 hours, depending on the topic	Oct. 2014
4 Turkey	Nanoscience	13	Feb. 2015

5 Portugal	Genomics, oceanography, polar science and climate geo-engineering	7-8	Nov. 2014
6 Italy; Bologna Palermo	Nanoscience and Nanotechnology Sub-topics: nanomaterials for energy production and nano-sensors to improve our perception of the world	12-19	Oct. 2014 Oct. 2014
7 Finland	Climate change	8	Oct. 2014
8 Greece	Nanoscience applications (size- dependent properties)	8-12	Nov. 2014
9 Poland	Catalysis in environmental protection, nanotechnology	10	Feb. 2015
10 Romania	Nanomaterials	20-40	Dec. 2014

Table 3: Gender Distribution of Irresistible Teachers and Students

Country	Total No. of teachers	Gender distribution among the teachers		Total No. of students	Gender distribution among the students	
		M	F		M	F
1 The Netherlands	8	3	5	162	81	81
2 Israel	5	0	5	147	62	85
3 Germany	10	6	4	101	57	44
4 Turkey	8	2	6	109	64	45

5	Portugal	8	0	8	216	105	111
6	Italy (Bologna)	4	1	3	139	101	38
7	Finland	16	2	14	95	16	14
8	Greece	5	3	2	95	50	45
9	Poland	9	3	6	146	55	91
10	Romania	6	1	5	159	66	93
	All project	79	21	58	1361	689	672

4. Examples from the Modules

4.1 Example of how the 6E Model was used in the modules.

For example, in the Turkish module on "Antibacterial Activity of Silver-Nano Particles in Hospitals," the 6E model was used in the following way:

Engage: Students view a newscast on the problem of a high rate of infections in hospitals. They read a short popular article about the possible solution of using silver-nano particles with antibacterial properties in hospitals, to solve this problem.

Explore: Students conduct an inquiry laboratory experiment in which they test the antibacterial effect of silver-nano particles on the reproduction of E. Coli colonies in petri dishes.

Explain: Students explain the results of the experiment and highlight the relevant concepts behind this phenomenon. Students discuss the possible outcomes and risks of the changing amount of silver ions regarding the ethical issue (RRI).

Elaborate: Students read a scientific article about the anti-bacterial effectiveness of silver-nano particles.

Exchange: Students design and construct exhibits relating to the question: "Should hospitals use silver-nano particle products to protect patients against infections?" In the following section we elaborate on the Exchange aspect of the modules.

Evaluate: Students assess their own knowledge skills and abilities. They evaluate their exhibition using a rubric that was developed for that goal.

4.2 Examples of the design and construction of exhibits in the modules

Since the Exhibit (6th E) is an additional E to the 5E model we will provide some examples from the other CoLs. In the German example, students designed and constructed exhibits on the topic of "Plastic Pollution in Oceans". They constructed their exhibits using a low-cost series of cubicles from IKEA. In the Portugal example on the topic of "Evaluation of earth's health through polar regions" the students built interactive exhibits using ICT tools

such as digital poster (Glogster), games (Fold play), Videos (Moviemaker), Comics (Pixton).

4.3 Examples how RRI was introduced in the modules.

In the Weizmann module on the use of Perovskite-based photovoltaic cells, the RRI dimensions were introduced in two cycles: (a) a special classroom-based unit on the RRI dimensions ("The Story of Lead"), and (b) activities used during the visit the Weizmann in which the RRI dimensions were applied to different contexts.

In the first cycle, the students are presented the history of lead use, starting in Roman times and progressing to the use of lead in paints and gasoline. They are challenged to analyze this case history and identify different factors that could have prevented the catastrophe of lead poisoning. In the following discussion, the 6 RRI dimensions are amplified and further defined. In the second cycle, the students apply these dimensions to (a) the case of Perovskite-based photovoltaic cells, and (b) current on-going research that is presented to the students by Weizmann PhD students.

5. Difficulties in the Modules and Plans to Address Them

The following table summarizes the challenges faced in the modules and in the work with the first CoL, and plans to address them in the second CoL

Table 4. Difficulties in the First CoL and Plans to Address Them in the Second CoL. These difficulties are summarized in terms of (a) module development and (b) work with the first CoL participants (teachers or student teachers).

	Difficulties in the First CoL	Plans to Address these Difficulties in the Second CoL
1 The Netherlands	<p>a. Due to the novelty of the module's topic, the CoL meetings focused mainly on the science and less attention was given to RRI and the 6E pedagogy.</p> <p>b. The teachers often did not make their deadlines in delivering their materials.</p>	<p>a. Now that the module has been developed, the CoL meetings will focus more on RRI and the 6E pedagogy. Also, a Facebook group has been initiated, in order for teachers to share their ideas about how to implement these aspects.</p> <p>b. Now that the module has been developed, teachers will have more time to devote to implementing RRI and the 6E pedagogy.</p>
2 Israel	<p>a. The CoL members found it difficult to integrate the RRI, 6E and exhibit-design</p>	<p>a. Through a series of class visits, different versions of the module evolved, ending with a version that</p>

	<p>aspects into the module.</p> <p>b. The teachers had an especially difficult time teaching students about RRI during the visits to the Weizmann Institute.</p>	<p>did integrate these three aspects.</p> <p>b. The CoL developed an interactive and attractive pre-visit unit on RRI ("The Story of Lead"), which gave the students a good introduction to the topic, before their visit to the Weizmann Institute.</p>
3 Germany	<p>a. The separation between the northern and southern groups resulted in different lesson requirements (25 lessons for the northern and only 8 for the southern groups). Also, it took a while to integrate the 6 RRI dimensions into the module.</p> <p>b. There was almost no exchange between the northern and southern CoL groups. Also, teachers didn't consult with the researchers when trying to address content issues.</p>	<p>a. In the second CoL, there is no issue to have different lesson requirements: there will be different CoLs developing short and long teaching modules. Also, a document describing the 6 RRI dimensions and illustrating them with examples will help teachers implement them in the modules.</p> <p>b. The northern and southern groups will now be recognized as two different CoLs. Also, an "Ask the Researcher" service will lower the barriers for teachers to</p>
4 Turkey	<p>a. It was challenging to integrate IBSE, RRI and Web 2.0 and the scientific content for the different age levels. Also, it was a challenge to prepare the teacher and student guides.</p> <p>b. Teachers were discouraged by (1) the length and timing of the meetings, (2) having to be committed to a CoL group and (3) having to spend their personal time to receive professional development.</p>	<p>a. The second CoL will devote more time to obtain a variety of resources for different age groups.</p> <p>b. The second CoL will (1) have less meetings and a more regular schedule, (2) provide extra support to the teachers, when needed, and (3) arrange meetings at the times agreed upon by all the CoL members.</p>
5 Portugal	<p>a. Teachers did not have access to the whole module</p>	<p>a. All of the module will be available from the beginning of the</p>

	<p>until the middle of the school year</p> <p>b. The vast majority of teachers had difficulties in including the RRI aspects in the modules and in their classrooms</p>	<p>school year.</p> <p>b. The project will provide a closer support to the teachers in the second CoL regarding RRI by members of the first CoL.</p>
6 Italy (Bologna)	<p>a. Teachers had difficulty integrating the module's scientific content with the RRI aspects for their students, since this was a new perspective (with a new vocabulary) for the students.</p> <p>b. Time management and working in an interdisciplinary team were challenges for the teachers in the CoL.</p>	<p>a. The second CoL will devote more time to help teachers design specific activities for their students to integrate the module's scientific content with the RRI aspects.</p> <p>b. The second CoL will focus on helping teachers manage with time in the implementation of the module. The involvement of teachers from other disciplines will be facilitated from the beginning by suggesting topics for collaboration.</p>
6 Italy (Palermo)	<p>a. Teachers felt that they didn't have enough time to develop the module.</p> <p>b. Teachers felt that they didn't have enough time to implement the module.</p>	<p>a. The module is ready and therefore the teachers will have more time available to them for implementation.</p> <p>b. The module has been modified and shortened, so teachers will have enough time to implement the module.</p>
7 Finland	<p>a. The student teachers did not include tasks for RRI in the module. They were too involved with exhibit items to focus on teaching in the module. Also, the teacher's guide was inadequate, and there was too little time.</p> <p>b. Student teachers had difficulty applying 5E, RRI and climate change simultaneously, They are not experienced teachers, so this may be too much for them.</p>	<p>a. All student teachers will share their ideas and best practices. They will be encouraged to make changes to the module, keep track of what is changed and why. The 2nd CoL student teachers will further develop and improve the teacher's guide.</p> <p>b. More time will be devoted to RRI and how to connect it to the 6E pedagogy. A tumblr blog will allow student teachers to add Finnish news articles for use in the module. The modules are ready now, so this will ease the design work.</p>

8 Greece	<p>a. It was difficult to obtain the appropriate materials for the experiments and to adjust them for the school conditions.</p> <p>b. It was difficult to arrange the CoL meetings, according to the needs of the different participants.</p>	<p>a. The second CoL will focus on using computer (interactive) learning environments.</p> <p>b. The second CoL will reduce the number of face-to-face and virtual CoL meetings by using a MOOC instead.</p>
9 Poland	<p>a. Too many topics were discussed at the beginning of the module development process, which left limited time to complete it. Also, it was difficult to convince the first CoL teachers that the module could be incorporated into the school program.</p> <p>b. The first CoL did not meet the needs of all the teachers; as a result, some teachers left the group. Also, the teachers were not convinced to apply the Web 2.0 tools.</p>	<p>a. The second CoL will work in interdisciplinary pairs of teachers; each will implement one foreign module. Detailed implementation information for each module and regular small-group meetings with the new teachers will help to support them in successfully implementing the modules.</p> <p>b. Detailed information on the project and its goals, the expectations and the working conditions, etc., provided at the beginning of the second CoL, should limit the number of teachers who leave the group. Working in pairs will be emphasized, which will provide mutual support. Each meeting of the second CoL will be summarized on Facebook, which will help teachers learn to use Web 2.0 tools.</p>
10 Romania	<p>a. It was difficult to develop a module which was well-adapted to the classroom conditions and the national curricula.</p> <p>b. It was difficult for the first CoL to find a schedule suitable for everyone.</p>	<p>a. The second CoL is now aware of this problem and will allocate the time necessary for the adaptation of the modules for classroom implementation, according to the national curricula.</p> <p>b. The weekly teachers' "Method Day" has been proposed for the CoL's meetings.</p>

4. Summary

Several changes have been made since the Month 3, in which we delivered the first WP-2 report (D2.1). The changes included changes in the length of the module (contact hours), building the students' exhibition in a different manner from their primary plans, delays in the date of having the ready module and changes that were done to adapt the module to the school curriculum.

These changes occurred when the partners adapted the proposals to their local educational contexts. The changes also reflect the dynamic nature of the CoLs. The authentic process of joint knowledge-building that takes place in the CoL meetings leads to the building of novel modules that differ from the ones that were suggested at the beginning of the process (D2.1, Month 3).

The partners also describe challenges faced in the first CoL and how they plan to address them in the second CoL. A common challenge was how to deal simultaneously with many sources of novelty and how to integrate into the module these sources of novelty, i.e., RRI, the 6E pedagogy, the new (often interdisciplinary) science topics, student-designed exhibits, and Web 2.0 applications. An additional issue was adapting the modules to school conditions and the national curriculum. In Germany, there was a geographical challenge of coordinating between the North and South groups.

In the project meeting held in Bologna on March 2015, two hours were devoted to discuss the difficulties in the first CoL. The following challenges were raised:

Different countries will have different strategies to tackle the recruitment of teachers. Some countries see this as a challenge; in Germany it was already difficult to recruit the first CoL, in Turkey it was difficult to make the teachers show up at all meetings. On the other hand, in Finland they work with teacher students who have to do the CoL as part of their educational training.

Well-prepared instructional meetings are needed to inform new CoL teachers of the RRI-aspects. These aspects are most likely new to those teachers and need to be explained correctly, in order for the teachers to be able to use these aspects in their teaching. Also, the content of the modules have to be communicated correctly.

To ensure appropriate instruction for the second CoL, all partners agree that at least three meetings are needed to do so. However, the challenge of designing modules with many sources of novelty will be less of a problem in the second CoL, since the modules have already been developed. The emphasis now will be on providing more quality support for the participating teachers; some partners are planning to have interdisciplinary pairs of teachers work together when implementing the modules.

Based on these challenges and on the needs of the project in the second round of the CoL (including the need to adapt two other modules by each partner), each partner has planned the second CoL. These strategies for the CoL2 will be presented in the report of WP-2 in Month 23 (D2.3).