Minutes and Action Plan of the

Workshop on Physics Education

11th & 12th of December 2014, Trieste, Italy

http://indico.ictp.it/event/7299/

http://see-cei-era.seenet-mtp.info/meetings/workshop-in-trieste/

The International Center of Theoretical Physics (ICTP), the United Nations Educational Scientific and Cultural Organization (UNESCO Office Venice), the European Physical Society- Committee of European Integration, the Southeastern European Network in Mathematical and Theoretical Physics (SEENET-MTP), the European Science Education Academy organised a workshop on Science Education to discuss and organise future actions and initiatives in the framework of the International Year of Light 2015 mainly focusing in Balkan countries. The workshop was supported by the Central European Initiative (CEI Trieste) and the large scale European Policy Support Action Inspiring Science Education)

Background

A Consortium consisting of EPS, ICTP, UNESCO Office Venice and SEENET-MTP, supported by CEI Trieste is implementing the Project "**Towards the integration of the physics community in CEI countries into the ERA**" during year 2014. This project is part of activities of the EPS Committee of European Integration.

The aim of project is to bring together scientists form Balkan and Central Europe, their partners all over the Europe, EU officials and science policy experts, to establish a strategic partnership between leading scientific institutions and researchers from South-Eastern, Central-East and Western European countries, as well as to consider concrete calls and forthcoming calls for joint projects in physics, sciences and education.

The main goals of project are to establish a strategic and project partnership between leading scientific institutions and researchers from SE-CE and European countries and to identify specific actions and to prepare joint applications of to Horizon 2020 Programme and similar European Programmes. This workshop is the 3rd and the closing one in frame of the project. The previous two are:

- **Workshop in Bucharest**, 25 – 27 May 2014
  "Widening Participation of CEI Countries in the EU Research Programs" – Training-Research in Physic, and
- **Workshop in Sofia**, November 23 – 25, 2014
  "Promotion of physics in the CEI countries and Integrating Access to Research Infrastructures in Europe"

It is also the 3rd workshop of the European Science Education Academy, the main partner in organization of the specific workshop and its output.

Rationale of the Workshop on Science Education

In recent times, Europe faces both a remarkable decrease in the interest of young people in Science, Technology, Engineering and Mathematics [STEM] subjects and a decline in the uptake of STEM careers. This general disinterest amongst young Europeans is more evident in the natural sciences. These shortages could not only affect the future of tertiary education systems but also jeopardize the pillars for a knowledge based society and economy in Europe.

During the past decade, this issue has been the focus of considerable attention and several documents have been published on this matter. For instance, the first of these reports - Europe needs more scientists (European Commission [EC], 2004) - stated that the spotlight should not be only focused on promoting more students to STEM careers but on improving the educational system itself. Another of these reports - Science Education in Europe: Critical Reflections (Osborne and Dillon, 2008) - states that even though there are several known shortcomings (curriculum, pedagogic, assessment), the real challenge is to re-imagine science education and try to both make it appealing and fit the needs of all students, whether they will go on to work in scientific and technical subjects, and those who will not. Following this work, the EC commissioned a report - Science Education NOW: A Renewed Pedagogy for the Future of Europe (EC, 2007) - that focused at successful projects that worked with the way science is taught in schools, concluding with an appeal to promote inquiry based science teaching techniques (Inquiry Based Science Education - IBSE) as a basis for improving the way science is taught in schools.

Following these recommendations, there have been many efforts focused on introducing IBSE at European level during the past years. From pioneering initiatives such as the Pollen project, which was implemented in 12 cities in Europe and provided initial guidelines for the implementation of IBSE to PATHWAY project - a project funded by the EC to promote the effective widespread use of IBSE in primary and secondary schools in Europe, which was implemented in 13 countries and has managed to offer professional development courses to more than 10,000 science teachers and the on-going large scale initiative called Inspiring Science Education that is developing a repository of tools and online labs to facilitate the introduction of IBSE in school classrooms across European countries.

A workshop organized by the European Physical Society (EPS) was held in 2013 (Crete, Greece) where several science education stakeholders discussed the aforementioned issues and strengthened the importance of promoting IBSE techniques and the importance of collecting the results of projects like PATHWAY to develop effective training programmes. This meeting laid the foundations for establishing a European education platform lead by education stakeholders, the European Science Education Academy. The European Science Education Academy was endorsed by EPS in October 2013. The second European Science Education

Academy Workshop took place in Bayreuth, Germany in March, 2014. The aim of the second workshop was to set-up the organizational framework of the European Science Education Academy and to discuss its operational scheme.

The aim of the **European Science Education Academy** is to set the pathway toward a standard-based approach to teaching science by inquiry, to disseminate methods and exemplary cases of both effective introduction of inquiry to science classrooms and professional development programmes, to support the adoption of inquiry based teaching by demonstrating ways to reduce the constraints presented by teachers and school organisation and finally to deliver a set of guidelines for the educational community to further explore and exploit the unique benefits of the proposed approach in science teaching.

The European Science Education Academy is expected to offer:

- Guidelines and methods for the introduction of inquiry based approaches in school practice in European countries (e.g. Best Practices in IBSE)
- Guidelines and methods for the organisation of effective teachers' preparation programmes (e.g. Guidelines for Designing Effective Outreach Programmes)
- Organisation of international events (conferences, training courses, contests) to promote inquiry based education (e.g. International Year of Light School Competition)
- Consultation services to policy makers and curriculum developers for the effective integration of inquiry based science education in the national settings.
- An extended web-based repository with relative materials (training courses, lesson plans, best practices in inquiry based science education) (e.g. Inspiring Science Education)

At the core of the European Science Education Academy exploitation strategy is its teachers professional development programme. The programme is focusing on science teachers, instructional leaders and curriculum developers. Facilitating the Inpsiring Science Education resources (a series of guidelines, scenarios of practice, tools, online labs and show cases from the numerous European schools) the programme can support participants to introduce innovative aspects in their school settings. The programme it is offered by the Open Discovery Space infrastructure in the form of webinars, interactive online sessions, 2 to 6 day long courses (e.g. ise.ea.gr) and field visits and observations in schools all over Europe.

Scope of the Workshop

In the framework of the specific workshop, the Consortium and the European Science Education Academy) aims to bring together scientists, EU officials and science education policy experts, as well as representatives of several SEENET-MTP nodes and partners to establish a strategic partnership between leading scientific institutions and researchers from SE and CE Europe with their partners from Western Europe, to develop a roadmap for the qualitative upgrade of science Education in Europe.

The aims of the workshop are the following:

- The present the developments on Science Education Academy, participants and their institutions;
- To consider the funding opportunities in 2015 for the common activities in the framework of the International Year of Light 2015; The aim is to explore the Erasmus + framework of teachers professional development programmes and the Horizon 2020 Science With And For the Society actions focusing on innovative teaching methods as a framework for the development of teachers professional development courses in Balkan Countries (first of all Bulgaria, Greece, Serbia, Romania) and Italy;
- To present International Initiatives in the Balkan Countries and EPS Committee of European Integration;
- To set the pathway for the next steps in 2015, as International Year of Light (e.g. common activities and projects, competitions, summer courses).

Outcomes of the Workshop

Participants discussed and developed a concrete Action Plan that could facilitate the opportunities offered by the International Year of Light 2015 activities building on the cornerstone projects supported by UNESCO in this framework. Following the presentation of the funding opportunities participants had the chance to discuss how each one of them can contribute to the development of the proposed plan. The plan is focusing on a series of teachers' professional development and Engagement Activities. In the next paragraphs we are describing the proposed plan.

A. Supporting Teachers from Balkan Countries to participate to the International Year of Light 2015 Summer School.

Participants agreed that they will work towards the development of a mechanism that will support teachers from Balkan countries to receive funding to participate in professional development activities in different European countries in the framework of ERASMUS+ teachers mobility actions. The European large scale Initiative Open Discovery Space has managed to mobilize numerous schools in Serbia, Croatia, Greece, Bulgaria and Romania the last two years. There is great potential and significant interest from the side of the teachers to get involved in such activities.

More specifically participants decided to develop a web site that will provide guidance and support for teachers interested to participate to the International Year of Light 2015 Summer School that will take place in Greece (July 2015). The programme of the Summer School can be found here: http://ise.ea.gr/content/programme-international-year-light-summerschool.
The website that provides information of the application procedure has been already developed and is available here: http://ise.ea.gr/content/how-apply. Participants have to contact their ERASMUS + National Agencies in order to get the application forms (e.g. http://ec.europa.eu/programmes/erasmus-plus/discover/guide/2015/documents/school-education-staff-mobility_en.pdf).

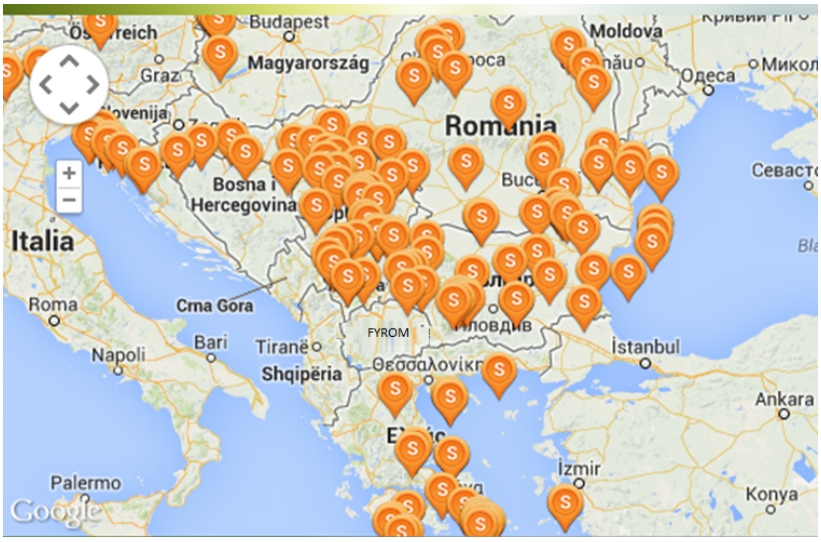

Figure 1: *The Open Discovery Space school network in Balkan countries offers numerous opportunities and could act as a starting point in our effort to implement innovations in science education.*

We will provide the necessary support and guidance to the teachers to fill in the application forms. We will provide texts about the rational of the proposal, the main aims and the educational benefits for the participants. The work will be done in cooperation with the participating institutions. The aim is to develop a mechanism that could support the organization of similar workshops in different places in Balkan countries (e.g. Athens, Varna, Nis, Spit, Craiova) in different periods during the year. In this way our team could involve numerous teachers from Balkan countries in numerous professional development activities. In the framework of these activities teachers will have the opportunity to interact, to exchange experiences, meet colleagues from other countries who are teaching similar subjects and dealing with similar problems.

B. Developing an ERASMUS+ KA2 proposal focusing on the development of a mechanism that could sustain the legacy of the International Year of Light 2015

Participants decided to develop collaboratively an ERASMUS+ KA2 that will design, implement and assess a science teacher's professional development programme that will focus on the use of the outcomes of the International Year of Light 2015 educational projects. These outcomes will be used as best practices that will be implemented in the participating countries to promote the use of innovative materials and innovative practices in school settings. In the following we are presenting the main objectives of the ERASMUS + programme and the main concepts of the proposed project.

The main objectives of the ERASMUS + programme in the field of education and training are to (the areas of interest of our proposal are highlighted):

- **improve the level of key competences and skills**, with particular regard to their relevance for the labour market and their contribution to a cohesive society, in particular through **increased opportunities for learning mobility and through strengthened cooperation** between the world of education and training and the world of work;

- **foster quality improvements, innovation excellence and internationalisation at the level of education and training institutions**, in particular through enhanced transnational cooperation **between education and training providers and other stakeholders**;

- **promote the emergence and raise awareness of a European lifelong learning area designed to complement policy reforms at national level and to support the modernisation of education and training systems**, in particular through enhanced policy cooperation, better use of EU transparency and recognition tools and the dissemination of good practices;

- **enhance the international dimension of education and training, in particular through cooperation between Programme and Partner-Country institutions** in the field of VET and in higher education, by increasing the attractiveness of European higher education institutions and supporting the EU's external action, including its development objectives, through the promotion of mobility and cooperation between Programme and Partner-Country higher education institutions and targeted capacity building in Partner Countries;

- improve the teaching and learning of languages and **promote the EU's broad linguistic diversity and intercultural awareness**.

The proposed project will be a **Strategic Partnership project** in the field of Education and Training. Strategic Partnerships aim to support the development, transfer and/or implementation of innovative practices as well as the implementation of joint initiatives promoting cooperation, peer learning and exchanges of experience at European level. Strategic Partnerships should involve the most appropriate and diverse range of partners in order to benefit from their different experiences, profiles and specific expertise and to produce relevant and high quality project results. To be funded, Strategic Partnerships must address either a) at least one **horizontal priority** or b) at least one **specific priority** relevant to the field of education, training and youth that is mostly impacted
(http://www.iky.gr/eggrafa-eplus/odigos-eplus/item/download/2591_80bf34cbe4ca93b782945eac3760285b).

Table 1: *Horizontal and Specific Priorities of the proposed KA2 strategic action*.

Horizontal Priorities	**developing new approaches** to strengthen the education and training paths of prospective and practicing educators; equipping them with all competences and skills needed to deliver high quality services and address increasingly diverse needs e.g. those posed by multicultural societies. In particular, priority will be given to activities building effective partnerships between providers and educational institutions (e.g. HEI/teacher training colleges and schools); co-ordinating approaches among providers as well as through collaboration and dialogue with key stakeholders and partners;
	enhancing digital integration in learning, teaching, training at various levels: promoting access to and learning through Open Educational Resources (OER); supporting ICT-based teaching, training, as well as ICT-based assessment practices. In particular, supporting teachers, trainers, educational staff in acquiring or improving the use of ICT for learning and related digital competences; supporting organisations active in education, training review their business models; promoting OER in different languages and produced in Europe; supporting digital integration in learning to reach audiences of disadvantaged backgrounds; exploring the potential of learning analytics and crowd-assessment to increase the quality of learning;
Specific Priorities in the field of School Education	strengthening the profile of the teaching professions through attracting the best candidates to the profession and by supporting teachers and leaders to deliver high quality teaching, deal with complex classroom realities and adopt new methods and tools. In particular, improving initial teacher education and supporting new teachers so that they have all necessary competences right from the start including in dealing with diversified groups of learners (such as migrants); to adopt collaborative and innovative practices to strengthen leadership roles in education, including distributed leadership, for designing necessary changes and improvements at institutional level;
	addressing low achievement in basic skills through more effective teaching methods. In particular, through projects that: foster multidisciplinary and inter-disciplinary approaches; integrate the teaching of basic skills (maths, science and literacy); promote problem-based learning; or foster innovative approaches to teaching technology-rich environment with particular

	focus on mathematics in technology-rich environment;

In this framework the proposed Strategic Partnership will develop a training framework that will promote the outcomes of the International Year of Light educational projects and will facilitate their integration to school curricula in the participating countries and beyond. The training framework will promote inquiry based approach that has proven its potential to increase students' interest in science while at the same time is supporting the development of key skills (e.g. problem solving, critical thinking) for students. The proposed project aims to demonstrate innovative ways to involve teachers and students in *Science* through the use of existing tools (see below for an example) in order to spark young people's interest in science and in following scientific careers. It aims to support policy development by a) *demonstrating effective community building* between researchers, teachers and students and empowering the latter to use, share and exploit the collective power of unique scientific resources (research facilities, scientific instruments, advanced ICT tools, simulation and visualisation applications and scientific databases) in meaningful educational activities, that promote inquiry-based learning and appreciation of *how science works*, b) *demonstrating effective cooperation of science education with scientific research* through a monitored-for-impact use of *Science* activities, which will provide feedback for the take-up of such interventions at large scale in Europe and c) *documenting the whole process through the development of a roadmap* that will include guidelines for the design and implementation of effective educational and outreach activities that could act as a reference to be adapted for stakeholders in both scientific research outreach and science education policy.

International Year of Light Cornerstone projects: **Cosmic Light Educational Kit**

The project will assemble a tool kit, the Cosmic Light Educational Kit, with simple tools to address the proposed thematic of the ephemeris, in particular those related the nature of light, the impact of light in our knowledge of the Universe, its importance for our existence. The richness of the networks involved in this project will also allow for a rich cultural interchange experiences that will be part of the proposed effort. The outlined campaign aims to reach teachers and students all over the world. The kit will have some components in material format and several digital tools and resources. Tutorials for its use and training is foreseen in the framework of this project. These will take diverse formats: face-to-face in some countries, asynchronous and synchronous formats, according to the possibilities and needs of each partners. Thematic hangouts, related to the main cornerstones of IYL2015 and related to the components foreseen in this proposal will be promoted along the year. Accompanying training efforts will be implemented in order to empower teachers to the fill exploitation of the kit and its different components.

The project aims to target diverse social and cultural audiences and propose topics related to light in its rich variety and impact. Light as a source of life, light as a source of knowledge, light from the past, light from the future, light for inclusion. Colors we see and colors we don't see. A special component designed for children with visual impairment will be incorporated in the kit.

The main outcomes of the project will be:

- Training Framework – Training Modules
- Training materials and Examples of Best Practices
- MOOC and online materials
- Evaluation Tools and Assessment Report
- Road Map (Guide of Good Practice)

One issue that has to be decided is the coordination of the project. Participants agreed that they will explore with their national agencies the national priorities and will come back with their proposals. The exploitation plans of the project will be in line with the development of the European Academy of Science Education.

C. Developing an Science with and for the Society proposal focusing on the development of a mechanism that could sustain the legacy of the International Year of Light 2015

In this action we are targeting the upcoming call of Science with and for the Society Workprogramme (deadline September 15th). The participants discussed the possibility to submit a proposal (under the Coordination of the University of Bayreuth – Prof. Franz Bogner) that will build on the outcomes of the PATHWAY project (www.pathway-project.eu) integrating the outcomes of the International Year of Light 2015 projects. The core concept of the project will be similar to the Strategic Partnership proposal idea but the specific action will be implemented at large in Europe (not only in the Balkan area). The call text is following.

SEAC.1.2014.2015 - Innovative ways to make science education and scientific careers attractive to young people
Specific challenge: The Union needs all its talents to boost creativity and competitiveness. It needs an innovative science education which shall enable todays' and tomorrows' citizens to play a more active role in the Research and Innovation process, to make informed choices and to engage in a democratic, knowledge-based society. It needs young boys and girls to pursue careers in science, technology, engineering and mathematics (STEM), while at the same time adhering to the values embedded in Responsible Research and Innovation. In such a manner, the Union will reach the objective of a R&D intensity of 3% of GDP which is essential. Yet it has been increasingly difficult to attract adequate numbers of young people, to these domains and to avoid a brain-drain of talent from Europe. Therefore, a shift to innovative and effective methods is necessary, so as to raise the attractiveness of science education and scientific careers and boost the interest of young people in STEM.

Scope: The action aims to support a range of activities, which will raise young boys' and girls' awareness of the different aspects encompassing science and technology in their societal content and to address the challenges faced by young people when pursuing careers in STEM. It aims at bringing both girls and boys into the scientific world via formal and informal teaching and learning and to orient them towards undertaking scientific careers. In order to be more attractive, research careers should also be more closely linked to labour market needs. In this context, the potential orientation towards more entrepreneurial and multidisciplinary research careers should be recognised. The proposals shall focus on innovative, forward-looking science education methods and/or on incentives and measures to make scientific and technological careers attractive to young students, including actions addressing the challenges in offering long term career perspectives. They may inter alia make young people work with open-access educational resources; become familiar with the use of science media; make the link between creativity and science; appreciate the relevance of gender balance and dimension in research; understand the practical value of research ethics and integrity; actions. The proposals shall also foster sustainable and cross-cutting interaction between the different levels of the education system, research institutions and other establishments, industry, Civil Society Organisations (CSOs). Such proposals shall improve the attractiveness of science education and scientific careers to young people; address challenges in offering long term career perspectives, as well as raise awareness of the importance of trans-disciplinary research and Responsible Research and Innovation in the education system.

D. Developing a Science with and for the Society proposal focusing on a large scale Pan-European Outreach programme that will raise awareness on the scientific culture.

The participants discussed different opportunities to promote the introduction of scientific work to schools and to young people in general. The participants have great experience in organising a variety of events in this framework (e.g. masterclasses, virtual visits at CERN, remote labs and observatories, summer academies). Participants concluded that they will try to develop a project proposal in the framework of the upcoming Science with and for the Society call for proposals (September 15th). The proposed project will aim to demonstrate how a unique research infrastructure like CERN could act a catalyst in the development of an innovative science education which shall enable todays' and tomorrows' citizens to play a more active role in the Research and Innovation process, to make informed choices and to engage in a democratic, knowledge-based society. CERN is the most appropriate example to support this effort. According the recent OECD Report on the Impact of Large Scale Infrastructures on Economic Innovation and Society (OECD, 2014)[i] such large scientific organizations could act as **incubators for innovative ideas and projects** (even outside the mainstream mission), which due to the **open and democratic culture** of the organizations could develop

solutions for **major societal demands**. In the framework of the proposed project the consortium will present how innovative and creative educational methods and tools (adhering to the values embedded in Responsible Research and Innovation) could be used to **incubate this culture to science classroom settings**. Furthermore the cultivation of scientific spirit could help to overcome language or national curriculum diversities. Innovative methods of blending traditional ways for teaching science with artistic pedagogical aspects may help distant or multinational communities start building a more effective sense of cohesion, friendship and better communication towards a common target.

ISSI.1.2014.2015 - Pan-European public outreach: exhibitions and science cafés engaging citizens in science

Specific challenge: This topic will organise public outreach exhibitions and participatory events throughout the whole of Europe to engage citizens in science, drawing on the experience and capacity of science museums, Higher Education Institutions, science shops, scientific centres of excellence and innovation hubs, cities of scientific culture (e.g. building on the Seventh Framework programme PLACES initiative), but also grass root Do It Yourself (DiY) creative re-use communities (like movements, etc.), secondary schools, higher education centres, Non-Governmental Organisations (NGOs) and civilsociety organizations, local public authorities and other relevant stakeholders16. The topic will take-up and further develop the information and training material produced by the RRI Toolkit developed by the Seventh Framework Programme project RRI Toolkit.

Scope: Exhibitions and participatory events shall be interactive and adapted to local/regional conditions (i.e.: use of relevant case-studies) and shall take place in the local languages. Exhibits shall provide material for dissemination and make use of existing multimedia and other relevant technology (e.g.: social media, virtual reality, scenarios, gaming, etc.) and shall employ inclusive participatory techniques to engage with multiple publics (children, youth, women, adults, and other relevant stakeholders).

Alongside the exhibitions, the proposals shall also establish regular 'science cafés' in informal settings, during which emerging science and technology issues and their Responsible Research and Innovation dimension (e.g. debating the pros and cons of shale gas extraction, personalised medicine, energy mix, disaster risk management etc.) can be debated, engaging citizens and other relevant experts and local actors. Public feedback of exhibits and the outcomes of deliberations shall be collected and analysed in a structured way, to guide an internal learning process and provide policy support.
The Commission considers that proposals requesting a contribution from the EU of between EUR 3 and 3.5 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and

selection of proposals requesting other amounts.

[i] The Impacts of Large Research Infrastructures on Economic Innovation and on Society: Case Studies at CERN © OECD 2014 (http://www.oecd.org/sti/sci-tech/CERN-case-studies.pdf)