HOPE Annual Forum 2016

Constanta, 7 - 10 September 2016

The University of Bucharest in partnership with Constanta Maritime University organized the last forum of HOPE network in Constanța, on the Black Sea coast. More than 100 participants attended the event that was held on the maritime base of the university under a very pleasant weather. Roxanna Zus and Stephan Antohe, Vice Dean of the Faculty of Physics at the University of Bucharest welcomed the last forum of HOPE, celebrating the memory of our dear colleague Laura Tugulea during the first session of the forum on Wednesday 7th of September.

The next day, 8th of September started with **Nadine Witkowski** (Pierre and Marie Curie University, France) shortly giving some introductory remarks on the forum program. The first day of the forum was mostly dedicated for Working group 4 (WG4) and the session was started by **Aleš Mohorič** (Uni. Ljubljana, Slovenia) presenting objectives of WG 4. This working group was the largest of all with 44 partners joined and investigated situation of physics teachers. In the first meeting in Zagreb 2015 it was decided to make 3 sub-groups which focused on different aspects: 1) supply of physics teachers 2) pre-service education of physics teachers 3) professional development. During the second meeting in Riga 2015 the subgroups have finalized the tools – questionnaire and templates for good practice examples collection. Aleš Mohorič left the result to be presented further in the forum program.

The session was continued by guest speaker **Hans Fischer** (University of Duisburg/Essen, Germany). He contributed a presentation about professional knowledge of science teachers and consequences for teacher education. Regarding standards of teacher education, teacher educators should know which competences are not only validly tested with samples of student teachers at university or in-service teachers but also relevant for successful teaching and learning of students, and therefore should be taught in all phases of teacher education. From research point of view, the demand for practical relevance of standards connects teachers' education with the classroom and the quality of school instruction. But until now there are only poor connections between standards and theories; the choice of competences listed in the standards is characterized as more or less accidental, as standards are designed as governance tools and not directly applicable in classroom settings. However, all these standards are more or less plausible in everyday teaching practice, although not evidence-based from a research perspective. Hans Fischer gave an full-scale overview of the concept of professional knowledge and its consequences for the quality of teaching and learning physics.

After a coffee-break the 2nd session was started, which was focused on good practices in physics school teachers education field. The session was started by **Ovidiu Florin Căltun** (Alexandru Ioan Cuza University of Iasi, Romania), who presented informal school science labs that are known in German culture with the generic name Schulerlabors (SL). Besides the role of promoter of science to students and society SLs may represent poles of excellence in the initial and continuous professional development of teachers regardless of the subjects taught, regardless of the curricular areas in which

they are registered. Research carried out for two months at Saarland University started from these assumptions, justified by the current state of research and educational activities of the 11 SLs established at University of Saarbrucken: 1) SLs are a friendly environment for students and teachers involved in activities but especially to the students preparing to become teachers in various subjects. SLs is a learning environment as lively as a normal class but has a better control of disturbances that can jam the transmission of knowledge and practical values associated with them. 2) SLs are a source of inspiration and support for in service teachers that accompany group of students by giving them significant support in continuous professional development: a. they can find and perform at SL experiments, material and time resources available that lack at their school; b. the proposed experiments at SL may be related to the curriculum proposed in class but the way of implementation and approaches can promote a favorable image of science and technology, enabled even in place that were designed and made; c. procedures may be dedicated to new contents that have recently been introduced into school curricula and school are not yet ready to support by their practical resources; d. SL can introduce concepts by innovative educational methods and technologies that have entered or may enter in school laboratories.

The session continued with **Víctor López** (Autonomous University of Barcelona, Spain) speech about DIATIC. DIATIC (the acronym of "Design and application of digital activities"), is a community of practice that includes in-service secondary school physics teachers and science education researchers. The 30 members of this community of practice meet every month in Autonomous University of Barcelona (Spain), with the main purpose of designing teaching materials for their secondary school students. In DIATIC meetings, participants share ideas about how to design teaching materials that they will later apply in their schools, and they also provide feedback about those materials that have been previously designed and applied in schools. This process allows producing several iterative improvements in the designed materials, always based on empirical evidence. At the same time, all the designed DIATIC materials have some common features: (1) a physics-in-context approach, which allows students to perceive physics topics as something meaningful for their life; (2) the use of ICT for promoting inquiry and modeling with students (data-loggers, simulations, etc.); (3) the aim to promote students scientific competences (to explain phenomena scientifically, to evaluate and design scientific inquiry, interpret data, etc.), and to provide tools for teachers for evaluating these competences.

The session concluded with **Joan Borg Marks** (University of Malta, Malta) presenting a change in teachers' education taking place in Malta. Malta always strives to bring the best practice in the classrooms for its students. Parents' guide their children towards successful study paths with the aim of seeing children reap a fruitful future. Many teachers try hard to have their students achieve. This year the Faculty of Physics at the University of Malta celebrates 100 years since its inception. The University of Malta also has a Faculty of Education founded almost 40 years ago. The majority of physics student teachers are tutored in Physics by lecturers from the Faculty of Physics while also being coached in pedagogy by lecturers from the Faculty

of Education. This seems like a good student teacher preparation. Yet, somewhere along the line somebody must have posed the question: "Can teachers and teaching change for the better?" Joan Borg Marks introduced a new Master in Teaching and Learning programme, which arouse from

the concerns whether Bachelor programme is a sufficient for teaching education. Community of University of Malta, hopes that a new programme will be a change for the better.

The next session started with guest speaker **Laurence Viennot** (Université Denis Diderot, France) presenting critical reasoning as a component of teacher formation. In recent years, the prevailing tendency to emphasize competencies rather than conceptual structuring in encouraging students to engage with physics may lead, to an oversimplification of taught content and a consequent lack of coherence of pedagogical resources in current use. This in turn increases the need to consolidate the critical analysis of teaching resources and texts as an aspect of teacher formation. A question then arises: Can critical thinking be fostered in students and pre-service teachers without conceptual structuring and (more importantly) without foregrounding the pivotal role of coherence in science? What links can be identified between the development of conceptual understanding and critical attitude in physics students and future teachers? In operational terms: Can we help them to develop their critical thinking capability without a conceptual basis? Drawing on a series of investigations by Dcamp and Viennot with pre-service teachers, some elements of an answer are presented. Mappings of prospective teachers' intellectual path during extended interaction (about ninety minutes) with an expert reveal the entanglement of conceptual and critical development in interviewees, and some threshold effects. In characterizing students' responses when confronted with various explanations of a physical phenomenon, these studies elucidate conceptual markers as well as metacognitive, affective and critical indicators. Identified profiles of co-development include "delayed critique" and "expert anesthesia of judgment". On that basis, two possible formats are proposed for intervention in teacher formation, based on the detection of flawed explanations and on textual analysis of solved exercises, and the respective merits of these interventions are discussed.

After the guest speaker Round Table 1 "Teachers needs in different contexts" took place. The participants were:
Andrea Popescu-Cruglic, Stefan Ghinescu (University of Bucharest, Romania)
Marie-Blanche Mauhourat (General Inspector, Ministry of education, France)
Yaron Lehavi (Weitzman Institute of Science, Israel)
Silvano Sgrignoli (Italian Association of Physics Teaching, Bergamo, Italy)
Ion Bararu (Coach for professional development and Teacher, Colegiul National "Mircea cel Batran", Constanta, Romania)
Sorin Trocaru (General Inspector, Ministry of National Education and Scientific Research, Romania)

Andrea Popescu-Cruglic introduced a Bachelor course of Physics Teacher Education in University of Bucharest, emphasizing courses which had the most significant impact. Andrea explained that from students' perspective the most important courses were seminars where students had to conduct a lesson to their peers and real classes on the last year of Bachelor program. Andrea noticed, that prospect teachers are not taught how to empathically interact with pupils, making teachers distant from their class and not encouraging or motivating kids to learn.

Marie-Blanche Mauhourat introduced the system of education in France. Teachers in France are citizen servants and have to complete competitive exam. Candidates must have knowledge of

two subjects, as Physics and Chemistry are combined subjects in lower and upper secondary schools. For the last year the main reform is being conducted to increase graduation level of teachers, whereas at the moment only Bachelor degree is required. Since 2014 there is a MEEF Master's degree with sandwich training courses and workshops in ESPEs (high schools for teacher education) and practice schools. A lot of work done by the Ministry to build a coherent teaching formation, including national accreditation framework, reference tables of professional competences, national framework of the curriculum of the MEEF Master's degree and national specifications for the recruitment competitive exam.

Yaron Lehavi talked about challenges of teachers' education in Israel. For five years there is a team of researchers in Weitzman institute who are communicating with 25 community leaders. These community leaders manage about 200 physics teachers, which is 1/4th of all in service physics teachers in Israel. The cases covered by the community mostly relate with teacher's everyday reality, developing content knowledge and PCK. The challenges of the system are how to reach more teachers, how to preserve enthusiasm. These communities are the infrastructure to foster and share the ideas. The other aspect Yaron shared was special PCK, consisting of both Physics and Math knowledge. The last thing Yaron mentioned was video-didactics: teachers are encouraged to video-record themselves and discuss a replay with a "coach" – colleague or trainer.

Silvano Sgrignoli in his talk stressed out the necessity of collaboration. This collaboration should be structured, embedded in teacher's job and must be compulsory. Silvano believes the idea that collaboration is actually needed by teachers and the solution to this call might be committees of practice, together with educational research groups. A broad objective is to have science teachers firmly convinced of the necessity and value of enriching their disciplinary content knowledge and of transforming it into a pedagogical content knowledge suitable for teaching. The main issue is Lack of time – lack of discretionary (unscheduled) time to share ideas, lack of common time with colleagues and lack of designated time for sharing, which, according to Silvano, should be explicitly dedicated for these tasks and there should be a sufficient amount of time in the educators' curriculum.

Sorin Trocaru reviewed over the physics in school teaching in Romania. Elements of physics start in primary school as a part of math and science. As a separate subject, physics starts at 5th grade. The system of teaching is spiral-form: the first approach is just the fundamental ideas, and afterwards the same topics are revisited with deeper and deeper understanding. Assessment of teachers consists mainly of inspecting the classroom by school inspectors. Sorin emphasized the self-ending circle: if the students don't have a good teacher at the secondary school they don't have the motivation and understanding sufficient to choose physics for their university studies. On the other hand, if the brightest students don't choose physics (or physics education) it creates the lack of good physics teachers. Teacher in Romania is not very respected position, nor is well financially supplied, therefore the problem becomes deeper.

Marina Michelini reviewed WG4 results about primary school teachers. Questionnaire results showed that physics education of primary physics teachers (PPT) differs – 2/3 university, post-secondary professional area, 1/3 is completely outside. Responsibility of PPT education is in different Departments/Faculties. Physics have few credits in education; scientific area is dominated by biology

science. Curriculum lacks experimental activities. Marisa pointed out an urgent need for EU to produce agreements as concern the basic requirement for PPT education, whereas now the research showed a lack of competences in content knowledge and adoption of a transmissive style of teaching notions instead of starting from ideas, curiosity and explorations of children to develop their reasoning.

The next day, 9th of September, started with thorough result presentation of WG4 by **Aleš Mohorič** (University of Ljubljana, Slovenia). The working group prepared questionnaire and received 52 answers from the network members. Questionnaire answers showed that many countries suffer of a shortage of physics teachers or foresee such a shortage within the next few years. Main reasons for this shortage are a lack of physics students in general and low financial attractiveness of the profession of a teacher. Only a few countries have established programs to overcome this situation. WG4 recommended to install Official programs (like in the UK, for example) to counteract the shortage of physics teachers. Roughly 2/3 of the partner institutions of HOPE offer training for physics teachers in secondary schools, rarely for primary schools. These institutions do not coincide with those being engaged in PER. The percentage of staff working in PER shows a broad range in the different institutions.WG4 recommended Institutions offering a training program for teacher education to provide facilities for PER. Most institutions offering an education for a physics teacher are also responsible for the curriculum, at least for the physics part. WG4 solution was that Physics Department should be responsible for the content of the curriculum of the teacher training, at least for the physics part of it. Survey showed that the majority of partners are involved in some kind of continuous professional development (CPD). The initiative starts mainly from the university departments. Just few partners take part in the evaluation of the cooperation. WG4 proposed recommendation that institutions which are not involved in in-service programs until now should start such actions. But also schools and teachers should be encouraged to express suggestions in which way physics departments can support science teaching at different levels. More institutions should take part in the evaluation of those projects they are involved.

The session was continued by **Marek Trippenbach** (University of Warsaw, Poland) report on working group 1, which investigated the ways to inspire young people to study physics. WG1 asked 1st Year Physics students why they chose to study physics at university via questionnaire and interviewing students (linked to questionnaire) to zoom in on reasons for choosing physics and on satisfaction with their physics course (why some think of “dropping-out”). The other focus was to ask University Physics academic staff about what they do to promote physics to young people and what they do regarding cooperation with schools. The questionnaire showed that internal Factors are rated very highly as a reason for studying physics at university. Internal Factors concerning a wish to understand how physics explains things dominate over a wish to enhance employment prospects. External Influences are rated significantly less highly than internal factors and the most influential external factor is the Internet. The External Influence with the greatest number of responses =5 (very important) is “Making or using a physics based device”. Questionnaire also showed that the percentage of female students of physics varies widely from country to country with the highest percentage being in Eastern Europe and the Balkans. Gender effects seem to be small in choosing

physics; however advice from the family is more effective for female students. The internet is more influential for male students. Female students become very interested in physics at an earlier age.

After a short coffee break **Hay Geurts** (Radboud University, The Netherlands) reported on the work done in WG2 which was focused on New Competences for Physics Graduates - Fostering Innovation and Entrepreneurship. The objective of the working group was to identify the new needs of the society and economy: what are the new challenges and opportunities in the context of innovation, entrepreneurship as well as management and policy where physicists might give a contribution, by conducting a survey of both alumni and employers of physicists. The network received 170 responses from alumni and 38 responses from employers. Another objective of the WG2 was to identify ways by which physics degrees programmes can be - or have been - improved in such a way that physics graduates are better prepared for the (new) job market, by conducting a survey in search of good practices and good cases studies amongst the HOPE partner institutions and including re-examination of existing physics competences (TUNING). The working group found out that physics alumni – working outside academia – rate a number of the so called "soft skills" as very important for their job, their employers come to a similar ranking and they feel there was too little emphasis on acquiring these skills during their study. A minority of the physics departments considers the development of entrepreneurial/enterprise skills as (very) important for their physics curriculum. For the majority of departments who consider this development as (very) important, their strategy is linked to an institutional strategy. Also, invited speakers from industry stressed the importance of specific "soft" skills (as supplementary to the traditional "hard" physics skills) and European wide study on employment of academic graduates resulted in a similar set of important skill domains (from employers' perspective). The recommendations of WG2 were to a) formulate a vision as a physics department of how to prepare students better for the future job market with respect to the acquisition of "soft" skills. Ideally this should be derived from a vision on university level; b) Investigate if and how "soft" skills are acquired inside the physics curriculum at this moment; c) If improvement is needed: 1) Use the examples of good practice as inspiration; 2) Try to work together with other departments of the university: they might have the expertise which is not present in the physics department - try to integrate acquisition of "soft" skills in meaningful projects (not isolated) which involve alumni of the university and employers of alumni.

The session was continued by **Eamonn Cunningham** (Dublin City University, Ireland) reporting on the progress of working group 3, which investigated future global challenges. The first topic of WG3 was students' recruitment and mobility, partnerships of universities and impediments such as language issues and fees. Another important issue was innovative teaching methods and physics education research (PER). Considering the first goal, HOPE network was too small to picture whole situation, so data from Mastersportal.eu was included in the research. The study showed that increasing availability of Masters courses in English makes mobility across Europe between Bachelor and Masters easier and reduces the attractiveness of English speaking countries, although other factors may reduce mobility, such as fees. Introduction of the Bachelor degree appears to have reduced mobility within the degree, except where there are inter-university agreements. However, there's no unified system throughout Europe: although Bologna process simplified mobility in between some countries, it's still very hard to incorporate countries with different education system

(i.e. UK). The second topic was mentioned only shortly, giving examples of innovative teaching methods, as most of them were covered already during Forum of the last year.

After the lunch break a new session – dedicated for perspectives – was started. The first speech was given by guest speaker **Pratibha Jolly,** (University of Delhi, India) about Global Challenges in Physics Education. She made an observation that the world order is changing fast. With all pervasive diffusion of technology, and consolidation of information and communication networks, communities across the world aspire to partake in development and be active participants in creation of an egalitarian knowledge-based global society. Increasingly, national goals recognize that a strong foundation in science and technology is critical for socio-economic growth. The commensurate focus is on creating and nurturing a scientifically skilled human resource at all levels. In particular, there is a greater understanding of the strategic importance of physics in interdisciplinary contexts as an instrument for addressing the grand challenges facing humanity. The spread of physics research and physics-based industries/enterprises is considered a good indicator of a nation's capacity to find innovative solutions for sustainable development goals. The young are expected to provide freshness of ideas and being given early opportunities to work on community-related projects.

Despite inherent focus, there remain globally shared concerns on dwindling interest in physics among young students, lack of inclusiveness, and flight of talent to other disciplines. There is a need to revitalize physics education in culturally relevant ways for diverse student populations. Seminal physics education research has motivated changes in content, context, instruments, and ways of teaching-learning of physics. There is special emphasis on creating active learning environments that integrate the use of a variety of resources to create experiences that are, both, hands-on and minds-on. Effective frameworks encourage peer learning and collaborative project work. It is expected that the classrooms of the future will be technology enhanced globally networked active learning environments. Scaling educational opportunities and outreach will necessarily entail creation of effective virtual modes. Dissemination of pedagogic innovations, however, is a major challenge. Transforming educational ecosystems is a complex task that needs appropriate curricular materials and teaching resources, determined and sustained by local initiatives. Foremost, it requires adequate professional development of teachers. Within this framework, Pratibha related initiatives undertaken by international bodies such as IUPAP, ICPE, UNESCO and ICTP for strengthening physics education, especially in developing countries. These have aimed at enhancing education outreach; providing access to equipment and resources; enriching teaching; and most importantly, developing sustainable collaborative models for capacity building of physics educators, through Educate the Educator series of workshops such as ALOP and Physware. The programs have led to formation of global networks of physics educators. They have also been successful in creating regional leaders equipped to trigger wide scale transformation through local action. These initiatives need to be further strengthened by providing educators sustained exposure to global examples of best praxis and greater access to eclectic resources through appropriate technology platforms.

After the presentation of the guest speaker some contributed papers were presented by HOPE partners, starting with **Olivia Levrini,** (University of Bologna, Italy) speaking about what inspires

young people to study physics. The talk was focused on the main results of an Interview based Survey of 1st Year University

Physics Students, carried out within Working Group 1. Among the HOPE activities, 112 interviews have been conducted in 16 universities, in order to investigate in some depth the factors that inspire young people to study physics and to identify possible critical factors which can produce the dropping out. The individual interviews have been carried out on a selection of students who had previously answered the WG1 Questionnaire on the inspirational factors, led by Gareth Jones from the Imperial College, London. In the talk, Olivia showed how the interviews helped WG1 to unpack the main results achieved with the questionnaire survey. In particular, she presented a comprehensive picture of "curiosity" which turned out to be the predominant motivating factor and showed how the interviews can throw extra light on reasons for comparatively low scores for factors like (i) enhancing employment prospects, (ii) effect of physics teacher, (iii) scientists in the family. Olivia emphasized the methods used to pursue the main purposes of the survey: a) to provide extra evidence supporting the validity of responses to questionnaires, b) to understand the different perspectives, interests and curiosity of students with respect to physics. Latter understanding may help academic curriculum developers and teaching personnel in the design of courses and instruction which better supports students' curiosity and interest, and thereby, keeps students active and motivated in their studies and future careers.

Another speech was given by **Edouard Kierlik,** (Pierre and Marie Curie University, France) on How to promote problem-solving on a large scale. 'Which is the temperature change of a glass of water when one adds an ice cube?' This question, asked without more guidance but with thermodynamics data of water, is one of problem solving given since three years in tutorials to students who followed the course 'Energy and

Entropy' at UPMC. The aim of this activity, intermediary between table-top exercises and inquiry based learning approaches, is to bring students to mobilize knowledge, skills and competencies to address a situation with a clear (often numerical) goal but for which the resolution path is not indicated. How this active pedagogy can manage the diversity and heterogeneity of students without increasing the number of 'tailored' lectures in the curriculum? How can students be made more active in their training? How to teach students how to address problem solving? How to evaluate works done when different paths can lead to the result? These issues have been addressed through an experiment conducted for 5 years in a top-notch curriculum with Science-Po Paris (3 ECTS - 60 students) before the course be expanded on a large scale for first-year university students (9 ECTS - 450 students, 18 groups).

The session was finished by **Philip Mörke,** (University of Konstanz, Germany), sharing experience of University of Konstanz. As in many European countries the number of science teachers, especially Physics teachers, for secondary schools in Germany is low and the number of students choosing to become physics teachers just high enough to compensate for the retirement rate. In the past, many of Germany's federal states tried to tackle this issue by either hiring physics professionals with no teaching background at all or to assign physics lessons to other science teachers. Unfortunately, both ways do seem to neither improve teaching quality nor raise popularity of the in general unpopular subject. Therefore, the University of Konstanz started a master's programme for

graduates with a purely scientific bachelor's degree in physics. In this master's programme the strong scientific background of students in physics and mathematics is supplemented by some more mathematics, but more importantly, by didactics, methodology and teaching experience at schools. In the last years they have seen the number of students in this master's programme rising constantly and the dropout rate remaining at nearly zero. Furthermore, a significant difference in motivation was noticed between the "traditional" students, who started with a teaching oriented programme from the beginning, and those coming from science but having reoriented towards becoming teachers.

The last day 10th of September was dedicated to future and perspective of HOPE network and started with the second round table on Strengths, Weaknesses, Opportunities, Threats analysis of Higher Education in Physics within a European context in the light of the activities and results of HOPE

The last round table of HOPE proposed by Ivan Ruddock has given speakers the floor representing each working group. The panel was composed of :

Olivia Levrini, University of Bologna, Italy
Gareth Jones, Imperial College London, United Kingdom
Sune Pettersson, Umeå University, Sweden
Maria José de Almeida, University of Coimbra, Portugal
Alexis Prel, Pierre and Marie Curie University, France
Pratibha Jolly, University of Delhi, India

The panel composition was drawn from the four Work Groups of HOPE together with input from a student with experience of mobility and one of the invited speakers to provide an independent and international view. Experiences of the panel put a light on the integration of the four working groups of HOPE.

The Forum was concluded by **Nadine Witkowski** (Pierre and Marie Curie University, France). She revised the HOPE network aims and results - great collection of data, with emerging conclusions and recommendations. Nadine reminded the scale of the network, connecting 71 partners from 31 countries. The network had 8 meetings and 3 Fora with lots of exchanges and discussions. Partners have prepared about 150 contributions (including talks and posters). She emphasized that results of the network are evidence based, rising from huge amount of data collected and analyzed. All working groups have reached their objectives focusing on different specific topics, but with common aspects. Nadine also pointed out unexpected results from open questions. HOPE network has given a significant amount of recommendations emerging from WG results and round tables, and integrate through the topics of the working groups. Nadine thanked all the partners, especially Laura Tugulea, Marisa Michelini and Ivan Ruddock for leading and managing HOPE network project, as well as Roxana Zus and Maritime University, for organizing the HOPE Forum 2016.