Abstracts of the Invited Talks in alphabetical order

Attila Aszódi (Budapest University of Technology and Economics, Budapest, Hungary):
Nuclear energy – acceptance or rejection

The Hungarian government signed an agreement with Russia in 2014 on the construction of two new units at the site of the four-unit Paks nuclear power plant. This decision – based on the National Energy Policy adopted in 2011 – determines the future of the Hungarian electricity production for the next decades. Public acceptance of a new nuclear construction can be a key point of the success of the project, which is determined by the public awareness. It is essential to educate environmentally and socially conscious youth, but also to provide them with the necessary technical knowledge to ensure that the next generation can have a well-based judgement of energy-related issues instead of emotional approach. The presentation gives an overview about the Paks 2 project and the possible methods of information and education of the next generation concerning the energy policy including the new nuclear units, paying special attention to explaining the safety and environmental effects of the new reactors.

David Featonby (Science on Stage Europe, United Kingdom):
Science on Stage Europe – inspiration for teachers by teachers

Science on stage is a network of and for science and technology teachers of all school levels which provides a European platform for the exchange of teaching ideas and highlights the importance of science and technology at school and among the public, through it's biannual festivals, its exchange programme for both ideas and teachers, and its joint working projects.

Ulrike Feudel (Institute for Chemistry and Biology of the Marine Environment, Oldenburg, Germany):
How to get highschool students interested in science: Lessons from the analysis of complex system in nature

We discuss how simple practicals can introduce the theory of complex systems to students in highschool. To show the connection of this theory to processes in nature we use a collection of simple systems describing natural phenomena. One natural system covered by this approach is the thermohaline ocean circulation as a prominent example from climate research. Discussing the emergence of oscillations in population dynamics does not only shows how methods of theoretical physics are used in other disciplines like ecology but also emphasizes the importance of bridging disciplines to tackle problems in nature. Starting from simple maps one can give some insights into the properties of chaotic systems, e.g. using the logistic map as a model for the competition of individuals for resources. By employing such simple models one is able to explain basic phenomena observed in complex systems in nature like self-sustained oscillations, chaos and bifurcations to highschool students.

Miha Kos (House of Experiments, Ljubljana, Slovenia):
Doubtology (Science adventure – an interactive talk)

The concept of "teaching" needs to be redefined into "inspire to learn". We are aware of the fact that our knowledge is made out of the stuff we learned by ourselves because we were curious and interested in the topic. A good teacher (inspirer) triggers curiosity, questions and debate among the students. It is also important to be aware of the importance of encouraging doubts and critical thinking in the inspiring (teaching) process in order to induce creativity. The Doubtology is a science adventure (show) that "plays" with people's common sense and plants some seeds of doubt.

Marisa Michelini (GIREP President, Physics Education Research Unit, University of Udine, Italy):

Research based proposals to build modern physics way of thinking in secondary students

Conceptual knots in classical physics are often quoted to argue the exclusion of modern physics in secondary school, but the physics of the last century is now part of the secondary school curricula in many EU countries and in the last 10 years appear in secondary textbooks, even if in not organic way and with a prevalent narrative approach. Therefore, a wide discussion on goals, rationale, contents, instruments and methods for its introduction in secondary school curriculum is now increasing. Modern physics in secondary school is a challenge which involves the possibility to transfer to the future generations a culture in which physics is an integrated part, not a marginal one, involving curricula innovation, teacher education and physics education research in a way that allows the students to manage them in moments of organized analysis, in everyday life, in social decisions. In the theoretical framework of the Model of Educational Reconstruction, we developed a research based educational proposal organized in five perspective directions: 1) the analysis of some fundamental concepts in different theories, i.e. state, measure, cross section; 2) problem solving by means of a semi-classical interpretation of some physics research experimental analysis techniques; 3) the study of phenomena bridging different theories in physics interpretation, i.e. diffraction; 4) phenomenological exploration of new phenomena, i.e. superconductivity, 5) approaching the basic concepts in quantum mechanics to develop formal thinking starting from phenomena exploration of simple experiments of light polarization. Research is focus on contributing to practice developing vertical coherent content related learning proposals by means of Design Based Research to produce learning progression and finding ways to offer opportunities for understanding and experience what physics is, what it deals with and how it works in operative way. Empirical data analysis of student reasoning in intervention modules support proposed strategies. The talk will present the research outcomes in terms of the approaches and the paths proposed for the last three perspectives: diffraction proposal, superconductivity phenomena exploration and quantum mechanics proposal.

Zoltán Néda (Babes-Bolyai University, Cluj-Napoca, Romania):

All-pervading light – or how the kinematic of modern physics is grounded on light

Light, and electromagnetic waves in general, are our basic and most important source for getting informations about the Universe around us. Have you ever thought on how the physics of a society who never experienced electromagnetic waves would look like? Have you ever wondered on how the space-time entity of physics is built? Have you been fascinated about the none-existence of "ether" or an absolute reference frame for the propagation of light-rays? If Not, probably you do have problems in understanding the essence of the special theory of relativity. If Yes, you should probably skip this talk and the rest of my abstract. After reviewing some basic knowledge about light, here I propose to rigorously construct the basic entities of kinematics. The main tool will be electromagnetic waves, and particularly light-rays. Both the geometry of the physical space and the physical time in any point of a reference frame will be defined using light-rays. After such a mathematically orthodox construction, the special theory of relativity will result naturally, and "ether" will be lost forever. One will clearly understand and easily accept all those puzzling consequences that makes presently the theory of relativity hard to digest. My believe is, that such an approach could be extremely useful in teaching the main ideas of Einstein's relativity theory for high-school and/or university students. I am glad to deliver this talk in 2015, the year which was proclaimed by the UNESCO as the "International year of light and light-based technologies." This was not on purpose, nor was it a coincidence, but rather, as Jung or Pauli would say, by synchronicity.

Hannu Salmi (University of Helsinki, Finland):

Bridging the gap between the formal education and informal learning via science centre pedagogy

To promote public understanding of science, new forms of education are actively being sought. A huge amount of information, especially about modern phenomena, is obtained in a personal way from family, friends and peer groups. Furthermore, the roles of television, libraries, magazines and newspapers, and of course by ICT and web-based reality are essential. Informal learning has often been regarded as the opposite and criticism of formal education. However, since 2000s, informal education has become a widely accepted and integral part of school system.
The number of science centres – and their visitors – have increased regularly during the last decade. Most of these forms of education can be classified as informal learning, either focused on young people via informal, out-of-school education programmes or as clearly informal learning occurring totally outside any educational institutes for young people or adults. We have to head towards the evidence based education via teacher training. There is all too much anecdotes and every-day-experiences related to science education and informal learning. There has to be more reliable link between research communities and teacher training.
The role of informal learning is increasing in the modern societies – meaning the countries which are developing their societies by investing and creating opportunities for research, innovations, and education. The phenomenon is closely related to the growing impact of science and technology in our everyday lives. Lifelong learning needs new practical forms, and the formal education can learn something from the informal, open learning environments like the science centres.
Science centres have been pioneering the hands-on science learning in Europe for the last decade. A science centre is a learning laboratory in two senses: First of all, it is a place where visitors can learn scientific ideas by themselves using interactive exhibit units. Secondly, it is a place where informal education can be studied in an open learning environment. The multidiscipline contents of modern science centre exhibitions form a unique and reliable learning source.

György Szabó (MTA Wigner Research Centre for Physics, Budapest, Hungary):

Game theory in secondary school

The traditional game theory provides a general mathematical framework to study quantitatively simplified real-life situations on the analogy of physics. The successful communication and application of many new relevant results in biology, human behavior, and social sciences can be supported by teaching the alphabet of game theory and some fundamental results in the secondary schools. Now we survey and discuss two elementary games illustrating the maintenance of cooperation among selfish individuals and the enhancement of social efficiencies for coordination type interactions. Additionally we briefly demonstrate how the games of theory of games can be played by students in classroom with the application of the modern tools of informatics. Experimental courses in secondary schools have indicated clearly that these enjoyable topics and approaches improve the activity of students and enhance their interest in mathematics and physics.

Miklós Vincze (MTA-ELTE Theoretical Physics Research Group, Budapest, Hungary, and Brandenburg Technical University, Dept. of Aerodynamics and Fluid Mechanics, Cottbus, Germany):

Modeling climate change in the laboratory

Due to the principle of hydrodynamic similarity the model flow of a shallow water layer in a tabletop-size rotating laboratory tank matches some key features of large-scale phenomena in the atmosphere and the ocean strikingly well. By heating the water tank at one of its lateral

sidewalls one can initiate a buoyancy-driven overturning flow that can be made similar (in the word's strict, mathematical sense) to convective flow patterns like Hadley cells in the atmosphere or the Meridional Overturning Circulation in the Atlantic ocean. The Coriolis force, arising when rotating the experimental apparatus, yields the formation of cyclones and anticyclones, which can be observed with dye tracing or via infrared thermography. Beyond the evident educational value of such a simple experiment (a perfect tool for the demonstration of the complexity of weather, and its basic underlying physics for students), similar laboratory setups are still actively studied in several research laboratories worldwide dedicated to environmental flows. Our von Kármán Laboratory, based at Eötvös University is one of these institutions. An experimental apparatus here, based on the aforementioned principles, has turned out to be a remarkably useful test bed to validate techniques and numerical models operational in weather forecasting. Our ongoing research is focusing on 'climate change' in such an experimental cofiguration. Climate change scenarios can be modeled by slowly, continuously decreasing the temperature difference between the two sidewalls of the tank, imitating the effect of global warming (which, generally, also yields decreasing equator-to-pole temperature difference on Earth). As these boundary conditions slowly change, we can observe how the 'weather' in the tank reacts to this non-stationary forcing. Such laboratory investigations may support the better understanding of the causal connections between global warming and the increasing number of unusually warm or cold seasons observed coincidentally in the past 30 years at the mid-latitudes of Earth.

Abstracts of the Contributed Talks in alphabetical order of the first authors[†]

Carl Angell (University of Oslo, Oslo, Norway):

ReleQuant – Improving teaching and learning in modern physics in upper secondary school

Quantum physics and relativity are demanding for teachers and students, but have the potential for students to experience physics as personally relevant and engaging. Project ReleQuant aims to improve teaching and learning in these topics in Norwegian upper secondary schools. In this presentation, we firstly present the principles for designing the quantum physics teaching unit focusing on how quantum physics breaks with classical physics and the students' use of written and oral language in their conceptual development. Secondly we present some results from our investigation of how Norwegian upper secondary physics students interpret fundamental principles in quantum physics while working with digital teaching resources developed in the project ReleQuant. Written responses and student discussions in ReleQuant have contributed to exposing student conceptions in quantum physics as multifaceted. Their discussions reveal that fundamental concepts in quantum physics are poorly understood. In the project ReleQuant we aim at designing material that can support students' qualitative understanding and epistemological reflections in modern physics.

Katalin Antalné Csorba (Britannica International School, Budapest, Hungary):

Data logging in the science laboratory or anywhere else

In the past few years there has been a growth of interest in how computers can be best harnessed in order to improve the efficiency and effectiveness of education. ICT toolkit is used due to limited infrastructure and the attendant high costs of access (e.g. software, updating). Data logging is a central feature of practical activity in the modern science laboratory. It provides the possibility for fast logging for physics in the classroom, long term recording for biology and out of door environmental experiments too. In my presentation I discuss the vital parameters of data loggers, which must be considered in case of shopping. I show how all the measuring activities may be readily performed using only a data logger. It is hoped the experiments will make it easier for teachers to introduce data logging to students in a meaningful manner.

Gerben Bakker (Melanchthon Schiebroek Rotterdam, University of Technology Delft, Rotterdam, The Netherlands):

Gamification in education

Games are great at engaging people and motivating action. Game designers deploy and tweak game-elements to maximise engagement and ultimately teach the player a skillset. The techniques applied are strongly supported by scientific motivation- and learning theory. Many of these techniques are far from novel in traditional education, but it seems gamedesigners have surpassed traditional educators in terms of streamlining learning processes and motivating 'students'. Gamification is about learning from games and applying game-thinking on the design of learning material to enhance engagement and motivation, without degrading the learning experience. In this presentation, examples will be given of gamification within the context of education and outside of it. The scientific foundation will be described and an overview will be given of publications on the subject. Finally, there will be a review of the main arguments against gamification in education, as well as some pitfalls and dangers.

[†]The first author is the one who submitted the paper. The affiliation of only this author is given in paranthesis.

István Basa* (Apáczai Csere János Highschool, Budapest, Hungary):

Application of computer simulations in modern physics education

Teaching modern physics is an essential, yet challenging part of our curriculum. Introducing the main scientific theories and discoveries of the past century, we often find ourselves with a lack of experimental resources in it. My goal is to develop and test computer simulations which can be used in high school teaching as a virtual science lab, where students are able to measure and observe modern physics phenomena. In most cases the technical conditions for real students' experiments are not given, or the observed phenomenon runs on an uncommon (ultra-fast or ultra-slow) time scale. Thus, a simulation is able to complete the students' experience already based on real observations. In this presentation I am about to show how a simulation (for experimenting with the photoelectric effect) can be made and used in physics education. I will show you some other examples of simulations based on this specific topic and I will make a comparison between them in their usability pros and cons.

Tamás Beke* (Our Lady Catholic Grammar School, Kalocsa, Hungary):

Simple model for the energy supply of a house using a hybrid wind-solar power system

A research project for secondary school students involving both physical measurements and modelling is presented. The problem to be solved is whether and how a typical house can be supplied with energy off-grid, based entirely on renewable energy sources, more specifically, on solar and wind energy, while using relatively simple devices, namely, photovoltaic cells, wind turbines and accumulators. To this end our students carried out a long term measurement series in order to assess typical energy consumption of houses. Further, the number of solar cells, the power of the wind turbine and the necessary accumulator capacity was estimated.

Szaniszló Bérczi, Ágota Lang, György Hudoba* (Eötvös University, Institute of Physics, Budapest, Hungary):

Measuring environmental physics and chemistry by educational Hunveyor and Husar space probe models

During the last decade various physical and chemical experiments were built onto the educational space probe models Hunveyor and Husar to measure soil and environment. The rover uses optical lens as classical heating experiment and uses several gas-sensors for measuring the chemical components liberated by the heating: demonstrating classical heating combined with gas sensor application. Experiment for pH measurements for chemistry of the soil: (1) Pump outpours water on soil, (2) water dissolves important chemical components from soil, (3) the indicator ribbon on one arm touches the soil surface, (4) color of ribbon reports the pH value in No. 2 arm, and (5) camera comparies this with color standard. Identification carbonate rock specimen of a planetary surface: (1) identification of carbonate by acid test, (2) measuring the gases liberated by acid, and (3) the magnetic test identifies iron component existence.

Árpád Bordás (Bolyai High School, Senta, Serbia):

Construction of a quadrocopter for low latitude vertical profile measurements

In the past two school years a low budget quadrocopter was constructed in Bolyai High School, Senta (Serbia). After the test flights the students designed an onboard data collecting system and equipped the quadrocopter with temperature, humidity, air pressure and GPS sensors. The first low latitude vertical profiles were obtained over rural area. Measurements were performed

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with the aim to understand land-atmosphere interactions during different atmospheric stability conditions. Further profiles were obtained close to urban meteorological stations installed during Urban-Path project (http://en.urban-path.hu/) in Szeged (Hungary) and Novi Sad (Serbia). The idea behind the investigations over urban area is to extend our knowledge about climate modification effects of cities useful for urban planning strategies.

Mária Csatáryová (Faculty Humanities and Natural Sciences, Department of Physics, University of Presov, Presov, Slovakia):

Historical experiment using virtual observation

Effective and interesting physics education is conditioned by exploratory character of activity of students. One aspect of how to support pupils' curiosity and imagination, but also the observation is to integrate teaching with historical observations of the night sky. Within the informal education, we can use virtual observation by means of astronomical computer programs EURO – VO (The European Virtual Observatory) that allow us the simulation in space and time and help us to explain individual phenomena in their historical context and discovery. The author presents the possibility of including selected historical components of observation in physics education by means of interactive computer programs and also describes her experience with such work.

Zoltán Csernovszky[*], **Ákos Horváth** (Kölcsey Secondary School, Budapest, Hungary):

The notion of energy in secondary schools and the experimental examination of photocells and photosynthesis

The lecture presents the comparative analysis and a model of photocells and photosynthesis. In the examination of the photocell we determine the cell's voltage-current characteristics and the maximum value of efficiency in terms of incident light intensity. We compare the impact of the photovoltaic effect taking place within the photocell, i.e. the energy exchange of the photons with the processes taking place inside a leaf during photosynthesis. By examining the absorption spectrum of the solutions containing leaf pigments, we present a simplified model of photosynthesis relevant from an energetic and biological perspective. We analyze the absorption of solar energy and its conversion to the other energies. Tackling the problem of energy storage, we underline that during photosynthesis the change in the electrostatic energy of the molecules does not result in an electric current.

József Cserti (Eötvös University, Deptartment of Physics of Complex Systems, Budapest, Hungary):

The beautiful rainbow

The rainbow is one of the most beautiful phenomena in nature. The formation of rainbows that can be seen when the sun shines through falling rain in the sky have been studied since ancient times.
We give a brief overview of the physics of rainbows ranging from the well known Descartes theory through the Airy's theory to the description of the light scattering by small particles based on Maxwell's theory.

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Daniel Dziob, Mateusz Wojtaszek, Dagmara Sokołowska (Smoluchowski Institute of Physics, Jagiellonian University, Krakow, Poland):

Reasoning quizzes in inquiry-based lessons

Academic Centre of Creativity (ACK) is a research project aiming to test the feasibility and effectiveness of the Inquiry-Based Learning (IBL) method and accompanying assessment tools. During the course of the project a set of new science units for primary school have been proposed to develop specific inquiry and reasoning skills. Five pre-service teachers have been trained in IBL methodology and after that each of them implemented ten IBL lessons in two classes. During this process each class has been observed by one researcher. This contribution presents results of reasoning quizzes taken after several lessons in four classes of the 5th grade on the topic of matter. Different types of tasks will be shown together with elaboration of pupil results.

Sándor Egri, Péter Ádám, Gyula Honyek, Péter Simon, Gábor Horányi, Ferenc Elblinger (University of Debrecen, Institute of Physics, Debrecen, Hungary):

Methods for teaching physics according to the curriculum framework "A"

The National Curriculum of Hungary and the curriculum frameworks for all subjects were renewed in 2012. The curriculum "A" for physics corresponds to the Science Education Standards applied all over the world. Novel books have been developed by the authors for teaching physics in secondary schools according to this curriculum. These books have been published by the Hungarian Institute of Educational Research and Development. In order to support physics teachers using these books, some novel methods have been tried and optimized by using the Cognitive Load Theory. These methods include, for example, learning about photo-excitation processes by using games, creating musical instruments using a smartphone application and problem-based learning about climate change using an online database. This communication summarizes the first results and experiences in this topic.

David Featonby (Science on Stage Europe, United Kingdom):

Colour blindness and science – 50 shades of muddy green intersperced with blues and yellows

Colour blindness or colour vision deficiency (CVD) is the most common genetic disorder in humans affecting 250 million worldwide. About 8% of males have colour vision deficiency, i.e. 1 in 12 boys in schools. Despite its prevalence many teachers do not realise that it is more than 'getting colours mixed up'; it is a problem with distinguishing colours across the spectrum. This can impact on the engagement, understanding, and attainment of a pupil. Teachers are aware of this disorder, but rarely have any training in dealing with the issues, rarely know who is colour blind in a class, and therefore rarely make any adjustments to lessons. There is little consistency across Europe in either assessment of CVD or strategies to deal with it, particularly in schools. Children and parents are often unaware that they are colour blind, and many teachers do not have a clear understanding of the special needs of colour blind children. Hence pupils can be severely disadvantaged and incorrectly diagnosed as being inattentive, underperforming, or requiring other types of special education needs support. There is very little information readily available as to how best to deal with this issue.
The seminar will
• Briefly describe the different types of CVD and their prevalence
• Give examples of science curricula where this is an issue, how CVD affects pupils attainment and self esteem, and give assessment examples which should trigger a teacher's alertness to a pupil with CVD
• Give examples of strategies that can be used at primary (junior) level and secondary level

• Outline some of the latest technological developments which can aid teachers understanding of CVD and pupils attainment
• Introduce the possibility of a group working to share best practice.

Zsanett Finta* (Nagy Lajos Secondary Grammar School, Szombathely, Hungary):

Complex students' experiments carried out with the help of a smart phone

Experiments which are carried out by the students themselves play a crucial role in teaching Physics. In this presentation a project work which was performed at the 2th Science Festival at Győr by secondary school students will be shown. A possible way of producing energy as well as the use of the produced energy for measurements was demonstrated by the students. A mobile phone was charged up with the help of a simple dynamo mounted on a bicycle and the necessary direct voltage was powered by 4 Graetz-bridges and the surplus current was used for operating a toy railway. The mobile phone, which had been charged up, was used for the determination of the acceleration of different types of movement (damped oscillation, pendulum, regular motion) For the measurements the "Accelerometer monitor" which can be downloaded from the internet freely onto a mobile phone was applied. The project work illustrates the most important features of the project-based learning, namely that students organized themselves their work processes and the teacher took on the role of „coaches" and was only the supervisor of the students work. A further important feature of the project is its highly interdisciplinary character and its connection with the „everyday life".

Csilla Fülöp* (Trefort Bilingual Technical Secondary School, Budapest, Hungary):

Physics teachers on teaching the radioactive decay law

Teaching the law of radioactive decay is a mandatory task in secondary schools. It is also one of the major problems in methodology. A survey was done among practicing teachers of physics in secondary schools in this topic. I am seeking for the answers to questions like these based on the survey:
• How do colleagues cope with this task?
• What aspects and motives can they rate high or name as the main insufficiencies?
• What methodological solutions are known? Which ones are in use? Which ones are liked?
The survey seems to suggest what conditions and needs are to be met in the methodological solutions in order to support success in the teaching practice in the secondary school classrooms. I will also present a project which can give a new solution in didactics to the problem. It is planned the "hands-on, minds-on" active learning way.

Csilla Fülöp*, Roland Szabó, Tamás Berényi, Balázs Simó (Trefort Bilingual Technical Secondary School, Budapest, Hungary):

The sledge project

„Why is it easier to pull a sledge up a slope than pulling it horizontally?" It is a question often asked, well-known among physics teachers. This is an issue in the classroom when analyzing friction, and motion on a slope. The answer is simple; at least it seems to be. Our little group made a deeper study of the question. We did Newtonian analysis by giving the equations of motion. This led us to a function of two variables. The analysis of this function goes beyond the secondary school curriculum. We numerically analyzed it with our program written in C++. We measured typical tilt angles of sledging hills, and typical friction values of snow-sledge surfaces. "It is easier to pull something up a slope than on level ground." Is this statement generally true or exclusively in case of specific conditions?

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Zsolt Fülöp (MTA Institute of Nuclear Research (ATOMKI), Debrecen, Hungary):

Towards edutainment: improving the public acceptance of physics

A new computer game has been developed to promote physics research. The main aim is a gentle introduction to Atomki labs through multimedia and reinforce the message: science is fun and useful, and it is everywhere in daily life. Using the game we also established a link between the history of physics and modern science.

The target audience is high school students interested in computer games, no physics background is necessary. The game application is role playing game to solve a mystery using physics. Real video footage helps the audience to get impression of a real physics laboratory.

Details of the game development will be presented.

Georgina Fröhlich (National Institute of Oncology, Centre of Radiotherapy, Budapest, Hungary):

Ionizing radiation in medicine – Radiotherapy

In the lecture an overview is given about a not widely known application of atomic physics, radiotherapy, focused on brachytherapy. Radioactive isotopes are implanted into the part of the body or tissue where the tumour is. The aim is always the tumour control without side effects, which can be reached by means of an appropriate treatment plan. The scientific research is aimed at analyse, develop of this plans and investigate different dose optimisation algorithms. Interstitial brachytherapy of cervix, breast and prostate are explained, highlighting some latest achievements.

István Gärtner* (Árpád Secondary Grammar School, Budapest, Hungary):

A few years experience of energy consumption in a high school in Budapest

I analyzed the electrical and heating energy consumption based on meters of data in years 2012-2014 in Arpad High School in Budapest. In my presentation I summarize the experiences which were obtained in evaluation and summary. On one hand, I compare the use of energy sources in our school, and, on the other hand, I mark the utilization of energy between the years and between the different periods of the years. I determine the amount of energy per person and per student groups too. After a short calculation I outline the possibility that our high school might want to change the mode of heating by using other energy sources. Finally I suggest potential solutions for reducing energy consumption which may lead to savings for the school.

Éva Gócz* (Lónyay Reformed Secondary Grammar School, Budapest, Hungary):

Simple experiments with semiconductors and LEDs

Semi-conductors play an important role in the everyday use of electronic equipment in modern life. Young people are eager to know how the devices they use may work and it must be noted that almost all the main features of those devices belong to the group of semi-conductors. It's important to realise that at secondary schools semi-conductors are unavoidable to teach about as they have become an inevitable part of preparation for any engineering profession. With semi-conductors in the teaching material we have the opportunity to let students know how the structure of natural sciences is built up from the very basic levels to its application in everyday practice. Via their studies about semi-conductors students may be given explanation to their previous studies on electrical appliances, regarding the reasons why metals conduct electricity

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and insulators don't; how the conductive and semi-conductive abilities of materials are dependent on the temperatures and lights circumstances of the area in which they are placed. Besides all the aforementioned advantages, the topic of semi-conductors is also cross-curricular, bridging the gap between other science subjects i.e. Chemistry and Physics. The efficiency of studies is higher for students when knowing that the things they have acquired in Chemistry lessons will be essential for their further comprehension of Physics during the terms to come. A few simple experiments are demonstrated, using devices that may be of help with better understanding for teachers and students alike.

Andrea Gróf* (Karinthy Frigyes Gimnázium, Budapest, Hungary):

Carousels to Coriolis. What did you learn in geography?

When geography is taught in year 9, underlying physical concepts and principles are lacking, or constitute recently acquired knowledge, not yet supported by sufficient experience. Explanations in geography texts disregard the physics curriculum and are superficial, or sometimes wrong. As shown by a survey with more than 200 students, they learn a significant part of geography without understanding it. While geography texts rely on inertial forces in explaining motions of the atmosphere and the seas, non-inertial frames do not feature in official physics curricula. With more background knowledge and expertise in applying quantitative relationships in problem solving, it is worth revisiting these geographic phenomena in physics lessons. A possible treatment within the limits of high-school mathematics is presented. Inertial forces are introduced through the classic example of experience on the merry-go-round, but quantitative conclusions are drawn and applied to motions in geography.

Mihály Hömöstrei*, **Péter Jenei, Péter Ispanovity** (German Nationality High School, Budapest, Hungary):

Benefits of IYPT in the physics education

Learning and teaching physics has many ways especially in our modern times. But probably, one of the best techniques of them is inspiration. Even if our students are not totally obsessed in physics, new and interesting challenges can make them change their minds. International Young Physicists' Tournament (IYPT) represents not only this new kind of challenge in physics and offers new ways in physics education but opens an entirely new horizon for our students – and not only in physics.

Zsuzsanna Horváth* (Kosztolanyi High School, Budapest, Hungary):

Search for Earth's twins

High school students are very interested in astronomy, specially, in the modern astronomical discoveries. To the most exciting recent discoveries belong the exoplanets. Among the about 2000 known exoplanets there are several dozens which orbit in the habitable zone of their host stars. There are some Earth-like exoplanets too. Finding a true Earth-like exoplanet, which may host life, is one of the main goal to search for exoplanets. We should illustrate to our students the differences and similarities between our and other planetary systems. Explore with our pupils the new wonderful world of exoplanets.

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József Jaloveczki (Szent László Education Centre, Baja, Hungary):

The motivating role of the full day experimental programme called "Physics show" in teaching physics

We organized this show for the eights time this year where students demonstrate and explain experiments in physics and chemistry to their fellow students. This presentation will provide a short review of the history and organization of the programs held annually. I will expose the steps of organization, the preparations and the implementation. I am going to give a short outline on what way the choice, the trials and the demonstrations of the experiments influence the participating students. I will report how the composite of the visitors, their number and their opinion work out during each program. With the help of my students we will demonstrate a few physics and chemistry experiments chosen from the former events showing how much these spectacular experiments can make teaching physics and chemistry exciting.

Márta Jávor[*], **Tamás Geszti** (Budapest, Hungary):

Decision making in a condominium – an Ising-like sociophysical system

Application of statistical physics methods to explain complex phenomena through simple physical models has been spreading since the 1970's. "Yes" or "no" answer to a question can be modelled by "up" or "down" state of an atom's magnetic monumentum. We illustrate decision making in a condominium through an Ising model of ferromagnetic ordering. When flat owners vote on an issue, being friendly or adverse to each other biases them towards accepting or refusing each other's opinion, that corresponds to ferromagnetic or antiferromagnetic coupling in the Ising model. Coupling gets weaker when participants follow each other with less attention; in the model that corresponds to a growing of the temperature. Some external motivating factors may shift opinions towards "yes" or "no"; that can be included in the model as external magnetic fields. We demonstrate all that by simulation in Microsoft Office Excel, exploring its Visual Basic facility in which parameters can be manually controlled. Making external fields different for each magnetic atom, coupling strengths different for each pair of them, would get closer to social reality, at the expense of making the physical model more complicated.

Darya Kazachkova, Maksym Peretiaha, Vitaliy Yurko, Anton Rusynyk, Daria Slobodina, Oleksandra Barkova (Karazin Kharkiv National University, ECYGDA at the Department of Physics and Technology, Kharkiv, Ukraine):

Three simple research projects made with household objects and recycled materials

In our work we are going to discuss and share ideas with our colleagues from Europe on how one can "teach to research" by the examples of three students' research projects:
• Simple experiments with sounds reported in English by Daria Slobodina and Aleksandra Barkova.
• Heron's Fountain made of plastic bottles, which are described in internet, and are a new non-typical pattern from the house hold objects designed by our students.
• Creation of the experimental set-up and demonstration of a "soap film liquid motor" which has been done by the students aged 14.
All those projects have been done at Educational Centre Of Youth Gifts Development where students have the opportunity to obtain an insight into the scientific method of investigation.

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Nataliya Kazachkova (Scientific Physics and Technology Centre (SPTC) in Karazin Kharkiv National University, Kharkiv, Ukraine):

Three stages of the students research skills development at ECYGDA laboratory

The work is dedicated to the informal methods in teaching physics. It will demonstrate the good practice examples and some difficulties of extracurricular physics trainings for the secondary school students aged from 7 to 16. There are three stages how students' experimental skills are developed. They have been realised during extracurricular courses at the Educational Centre of Youth Gifts Development ECYGDA which is situated at the premises of Karazin Kharkiv National University at the Department of Physics and Technology. During such training students gain special profound knowledge of physics and seriously improve their experimental skills by doing experimental projects using recycled materials, simple household objects or ordinary toys. The main problems of the physics teaching in Ukraine at the lessons and beyond will have been analysed and highlighted. We hope they will be interesting for the participants.

Andrea Király, Andrea Kárpáti (ELTE University, Faculty of Science, Centre for Science Communication, Budapest, Hungary):

Collaborative, ICTs supported learning solutions for science education based on the SSIBL Framework

PARRISE ("Promoting Attainment of Responsible Research and Innovation in Science Education", 2014-18) is an European Commission – Seventh Framework Program involving a transnational community of science teachers, trainers, communicators, and curriculum and citizenship education experts from 18 institutions in 11 countries. Its major objective is to engage young people in learning science through experiencing its societal impact. The presentation will introduce the educational framework for socio-scientific inquiry-based learning (SSIBL) developed and tested during the project in formal and informal learning environments and show how its components increase scientific literacy. The presentation will feature communities and tools that support these objectives.

Miklós Kiss (Berze High School, Gyöngyös, Hungary):

Neutron capture nucleosynthesis

Heavy elements are formed in neutron capture nucleosynthesis processes. Traditionally these are s-process and r-process. According to the classical view, these two processes are because of competition between the neutron capture and beta decay. We have proposed a simple unified model to investigate the neutron capture nucleosynthesis in arbitrary neutron density environment. We have also investigated what neutron density is required to reproduce the measured abundance of nuclei assuming equilibrium processes. We found both of these that the medium neutron density has a particularly important role at neutron capture nucleosynthesis. About these results most of the nuclei can be formed at medium neutron capture density environment e.g. in some kind of AGB stars. Besides these observations our model is capable to use educational purpose. We can show with it the neutron capture nucleosynthesis process at changing conditions. But we can show the various decay processes as well.

Miklós Kiss (Berze High School, Gyöngyös, Hungary):

Mikola competition

Back in 1981 we realized that there is no nation-wide competition in physics among the nine-ten grade students. To be able to identify students talented in physics as early as possible, we started to organize one. The competition consists of three rounds. The first and second

rounds mainly focus on tasks such as, theory and problem solving. The final round consists both theoretical questions and experiments. The usual venues for the finals are the Berze High School in Gyöngyös (nine graders) and Leőwey High School in Pécs (ten graders). For the finals the top 50 students per grade are selected from the thousands of participants of the first rounds. This year we held the 34th Mikola competition.

Annamária Komáromi* (King St. Stephen Secondary School of Music, Budapest, Hungary):

With space research for more lovable physics classes

I show in my presentation how one can motivate students with the results of space research, and make them more interested in the subject of physics. In Hungary the Masat-1, which is the first Hungarian satellite, presents an excellent opportunity for this. This spacecraft was designed by the Budapest University of Technology and Economics. It was made by students with educational purposes, and it was part of the cube-sat program of ESA. The scheduled lifetime of this little satellite was set for 3 months, but it worked for almost 3 years. Not only the Masat-1, but the satellites provide general opportunity for the motivation at many topics in our teaching of physics. I attempt to prove in my presentation that not only at the traditional areas (for example laws of Kepler) we can refer to satellites, but also in other topics, such as thermodynamics, or electrostatics.

Tamás Kovács, Márta Kis (Konkoly Observatory of the Hungarian Academy of Sciences, Budapest, Hungary):

How to merge technology and methodology in science and mathematics education – the GEOMATECH Project

Looking around the world there is no question that technology turns into the essential part of the everyday life. A proper combination of pedagogical methods and cutting-edge technology must be, therefore, a primary goal to education systems, on all level. One of the many attempts is the work that we are doing with colleagues in the GEOMATECH project in Hungary. GEOMATECH (http://geomatech.hu) is a large scale EU funded project, which aims to develop high-quality teaching and learning materials for all grades in primary and secondary schools in Hungary. These materials (1200+ Mathematics, 600+ Science) will be embedded into an on-line communication and collaboration environment that can be used as an electronic textbook, a homework system, and a virtual classroom environment. In addition to material development, we will offer 60-hour professional development courses for more than 2400 teachers in 800 schools in Hungary.

Imre Kuczmann* (Nádasi Ferenc Secondary School of Hungarian Dance Academy, Budapest, Hungary):

Transformations in physics

The treatment of the collisions at secondary school level is a nice application of the general principles of mechanics, namely the conservation of the energy and the conservation of the momentum. Unfortunately, the calculations generally lead to quadratic equations which do not belong to the curriculum of the 9th grade students. However, by transforming the coordinates into a system moving with the centre of mass of the colliding bodies the use of quadratic equations can be avoided, because in this system the speed of the colliding bodies is also conserved. Another interesting use of the coordinate transformations can be found in the theory of relativity. By the use of Lorentz-transformation it can be demonstrated that the quantum mechanical wave

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function is a result of the transformation of standing waves into the frame which is moving relatively to the first one. Namely the transformation of standing waves with an unlimited wavelength leads to moving waves of wavelength $\lambda = h/p$.

Borbála Leitner* (St Emeric Catholic High School, College, Kindergarten and Elementary School of Arts, Nyíregyháza, Hungary):

Experiences in teaching game theory in the high school

Investigations among primary and secondary school students indicated that young people know neither the concepts of game theory, nor its application to different sciences. This motivated us to start teaching game theory at an elementary level for three groups. According to our experiences the students were open and active participants mostly due to their emotional relationship to concrete life situations. In addition to traditional games we discussed some social dilemmas and coordination type games. At the end of the course the interest shown by the students and the knowledge acquired by them were analyzed by a questionnaire. In the future a more detailed teaching of game theory is planned in study circles to overcome the limitations of regular courses.

Dorottya Lendvai*, Márton Czövek (Berzsenyi Dániel Gimnázium, Budapest, Hungary):

Pendulum wave, or love at first sight

Pendulum wave is the motion of a chain of pendulums in which – if their length is chosen based on an appropriate mathematical relationship – remarkable shapes emerge. The most important question is: what should be the logic of composition? How long the cords should be in order for the pendulums to show nice shapes when they are initiated appropriately. We started to study this topic in more details with high school students in a physics camp. Students had to develop their chosen project work in a team with the support of a teacher. After clarifying the physical and mathematical background, younger students prepared the tools, while the more senior ones worked on the related computer simulation that facilitated more precise research. During continuous consultation, students enriched the project work with numerous unique ideas. Following the phenomenon's beauty and obscurity I had the idea of sharing my experience with others about a physical subject astonishing both youngers and elders.

Péter Mészáros* (Mobilis Science Center, Győr, Hungary):

Fire tornado at the Mobilis Science Center

The fire tornado is a special natural phenomenon that can be produced artificially. It is significant in the science centers because it is really spectacular and easy to show. It models a large range of phenomena in physics, technology and chemistry. It can be applied in experiments as well as in study groups. The popular device modelling the fire tornado has been developed by the Mobilis Science Center. One form of it has gained a prize. The phenomenon can be presented in several ways. At present, we have six different types of devices. We can demonstrate with these devices the turbocharger, the gas turbine, the conditions of burning, and the chemistry of flame testing. Several explanations (sometimes incorrect ones) can be read in publications or on the Internet. There is a complex hydrodynamic process in the fire tornado which is represented through experiments on the spot and a simplified explanation is given as well. Photos and videos are shown to demonstrate how it works.

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László Molnár* (Secondary Grammar School, Filakovo, Slovakia):

Computer based experimentation in secondary grammar school

It is a motivation for students interested in physics when they enrich their knowledge by experiments. The students are looking for an explanation after the experiments, thereby expanding their understanding of the phenomena under investigation. Activities in digital laboratory can be easily performed with a computer. Computers with CoachLab II+ or EuroLab perform collecting data from many different sensors within very short periods of time, displaying data, graphs and tables, analyzing data quickly and accurately. Computer measurement activities create many opportunities for exploring data and help to focus student attention on the interpretation of graphs. One of the most important features of these experiments is that every measurement is directly presented in graph. This visual representation of the measured data helps students to understand the relationship between a phenomenon and its graphical representation.

Vera Montalbano (Department of Physical Sciences, Earth and Environment, University of Siena, Siena, Italy):

Energy, food and sustainability

The food satisfies a basic need of living beings, but in human society it has assumed many other meanings (cultural, social, ritual, etc.). The supplied energy to the human body is trivialized by the indication of the calories on the packaging but it is completely disconnected from the students' scientific knowledge. Some learning path focused on the energy aspects related to food is proposed. Starting with the most obvious ones (how much energy is available to the body by eating a food and which relationship with the calories listed on the package) the students can explore the most hidden aspects of the topic, such as the energy cost for food processing, packaging, distribution, preparation and consumption. How much fossil fuel for obtaining a portion of spaghetti? The concept of sustainability is introduced and the evaluation of the dietary practices according to this criterion is suggested, helping to form citizens better informed and more critical about energy sustainability.

Éva Mária Oláh* (Mechatronical Vocational School, Budapest, Hungary):

Let's build particle physics!

Particle Physics is one of the fastest developing areas of science in the world. High schools do not have time to deal with this topic, so the students can get to study it after the regular lessons only. The students consider this topic too difficult. There are a lot of unknown terms, it is hard to imagine because the elementary particles are very-very small, they are invisible and their size is below 10E-18 meters. I have developed a low-cost educational material for teachers and students. It is easy to make and students can learn with them while playing. I try to present the mysteries of the micro world with paper cubes. I hope that this method will help teaching and studying Particle Physics.

Péter Palkovics* (Kontawig Vocational School, Eger, Hungary):

Mulidisciplinary teaching of natural radioactivity using the example of Radon

To understand several phenomena of our nature in the high school, it is better to keep the framework of the separate disciplines. But there are special cases when a complex approach can be more efficient. The secondary schools where there is limited time to teach general subjects, since the focus is on the profession, can be such kind of special case. This limited time will

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overview the effects corresponding to the question of Radon and its movement: its birth, migration to indoor air and its health effects. It is an important goal for the students to have an open look on the surrounding world, to be able to form a notion of the correspondence studied by physics, geography, chemistry and biology, to get an insight into the complex processes occurring in nature. By the review of the socially significant Radon problem, we have the opportunity to touch upon several disciplines.

Mária Pető* (Székely Mikó Theoretical High School, Sepsiszentgyörgy, Romania):

Robotics, CANSAT, ARDUINO – physics at Székely Mikó Science Club

What can we do when our students are boring during the activities or they are not interested into the topic? The Arduino board based on ATMEGA chipset or similar devices with few sensors or robotics can be the solution. I would like to present activities based on Arduino applications used by me during the physics class and Science Club. The CanSat is a miniature simulation satellite of the size of a 350ml can. The students project and build a space experiment, measuring pressure, temperature, air pollution, gases into the atmosphere and some basic data during the flight. This equipment is permanently in connection with the ground station. The data are collected from the sensors and analysed by the ground station. LIFEBOTS is special rescue robot projected and built by students at Science Club. This robot finds the victims after natural disasters, even in small and difficult places. It sends real time images about them and basic information about the health condition.

Károly Piláth (ELTE Trefort Ágoston Secondary Grammar Laboratory School, Budapest, Hungary):

Some of my favorite experiments

In my lecture I selected from my experiments those, that piqued the interest of the students as well, who had little interest in physics.
1) An experiment to prove the quantized nature of light: The most important feature of the experiment is that using the quantum characteristics of the light we can construct a device which is able to recognize the color of the light.
2) Energy transformation: I heat a Peltier modul with a gas lighter, which transforms the heat energy into electrical energy. A LED transforms this energy into light energy, then with transforming this into electric energy again, with solar cell we can make a mechanical electric motor whirling.
3) Infrared projection: In this experiment I use an infrared LED with a cheap plastic collimator lens. This parallel light goes through the "film", which is a photo, printed on clear film. The projector lens projects the image on the screen. The image which is invisible for us can be visible with the use of an infrared webcam.

Freek Pols (Technical University Delft, The Netherlands):

Real or fake? What can students learn from debunking Hollywood physics?

Many physical phenomena can be observed in movies and movie stunts. Although these events are, in terms of physics, far from accurate, they can be used to teach physics. As most movies appeal to a large audience, students' interest can be used to start an inquiry towards answering the question: real or fake? In this presentation (a movie), I show a few potential movie scenes which can be used in class as well ideas for further scientific research.

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Singha Prasitpong (Faculty of Education, Thaksin University, Mueang, Songkhla, Thailand):

Thai high school students expectations in learning physics in an interdisciplinary Science, Technology, Engineering and Mathematics (STEM) activity

To support students' knowledge and attitudes to a subject matter, an interdisciplinary STEM activity is useful, nowadays widespread accepted in Thailand. This research aims to study an effect of a STEM activity on Thai high school students' expectations in learning physics. It was monitored by using the Maryland Physics Expectations (MPEX) survey. These students ($N = 70$) were asked to agree or disagree on a five-point Likert scale with 34 statements of MPEX, both before and after the activity. This 3 hours STEM activity in this study focuses on the force and motion that asks students as a group to design and construct a toy car, which can roll down an inclined ramp with the maximum distance. Results of MPEX showed that students gave favourable (expert) responses on post-score more than pre-score, but less than 50%, for over all categories. The STEM activity most impact to reality link and effort areas, and less impact to concept area of the students' expectations.

Suttida Rakkapao (Department of Physics, Faculty of Science, Prince of Songkla University, Hat Yai, Songkhla, Thailand):

An item response theory analysis for the test of understanding of vectors (TUV)

This study aims to investigate the test of understanding of vectors (TUV) using a one-parameter logistic model of item response theory, Rasch model. The TUV, a 20-item multiple-choice test, was designed to diagnose students' understanding of vector concepts in a university level. The TUV was translated into Thai language, validated by experts, and modified to reach a statistically acceptable test. It was applied to 774 science freshmen of two universities in Thailand. Average score of TUV was (34.0 12.5) %. The Rasch analysis via the JMetrik free software revealed that 18 items of TUV had difficulty parameter in a desired range (-2, 2), with 1 discrimination value. But, item 6 of dot product concept had a difficulty value slightly lower than the desired (-2.31), and item 2 of unit vector concept had a difficulty value slightly higher than the desired (2.11). Overall, TUV contained items with different levels of difficulty values for monitoring students in different abilities.

Ibolya Ságodi-Dömény[*], **A. Ságodi** (Garay János Grammar School, Szekszárd, Hungary):

Light pollution measurement: a project work for secondary school students

One of this paper's authors manages a student group on environmental physics at Garay János Secondary Grammar School in Szekszárd, also dealing with astronomical observations, which necessitates dark nocturnal sky. Therefore, the group started to show interest in light pollution and made measurements with a special portable photometer (SQM) in a nearby area in Tolna county called Hegyhát. It obtained very good data, approaching those of Hungarian international dark sky parks' values. It also surveyed the sky glow of its hometown Szekszárd before the remodeling of public lighting system in summer 2014. In the meantime, a team of University of West Hungary measured the luminance of the town's light dome by DSLR photometry and obtained a slight decrease of light pollution after the lighting reconstruction. Therefore, to measure with SQM is a good future project for the student group to confirm the results.

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István Scheuring (MTA-ELTE Theoretical Biology and Evolutionary Ecology Research Group, Budapest, Hungary):

Scientific program in the summer camp "Bátor Tábor"

Bátor Tábor offers complex therapeutic recreation programs for children with cancer, diabetes, JRA or haemophilia. Campers can participate in programs such as rowing, horseback-riding, archery, arts & crafts, dancing, music, sports, etc. All programs are meant to provide a feeling of success, which positively influences their self-esteem and recovery process. From this summer the program "Magic Forest" changed meaningfully to focus on playfulness, experimental activity, creativity and personal revelation. Considering the time and financial constraints we compiled experiments and activities mainly on the field of hydrodynamics and electricity. We worked out specific programs for smaller children and teenagers and trained the volunteers to be the mentors of the programs. In the talk I present the structure of a program and show how playfulness and creativity is included in the program and how these elements effect on the recovery of the campers.

Erik Stengler, Guillermo Fernández, Pere Viladot (Science Communication Unit, University of the West of England, Bristol, United Kingdom):

What science centres are and aren't good at in supporting education

Science centres and museums have undergone a great evolution in recent decades although it seems that, lately, the science museum model has been somewhat stagnant. Since the radical changes of the mid-twentieth century, it has developed towards strategies in which visitor numbers take precedence over other considerations. Alongside a school science that could be described as "boring", a trend has emerged with a focus on "fun science" in science centres and museums, hoping to address current shortcomings. We question this view and propose the idea of "seducing science" as an alternative to achieve long-term impact of museum visits, with an emphasis on scientific museology principles and inquiry based learning.

Tamás Stonawski[*] (College of Nyíregyháza, Nyíregyháza, Hungary):

New possibilities in physics assignments and in facilitating solutions – the QR Code

The virtually endless use of smart phones has become part of our students' everyday life. However, instead of dissuasion and prohibition, it seems to be more promising to more actively involve smart phones in the teaching and learning process. Smart phones provide new opportunities in Physics assignments, in the experimental demonstration of the problem to be solved, or even in the graphical verification of the results. A QR Code can be attached to each exercise whether printed out on worksheets or given in electronic format. By reading the code with the smart phone, the user will immediately be directed to the website defined by the Internet code. Depending on the specific exercise various photos, videos or charts/diagrams can be uploaded for the purposes of demonstration. This way we can depart from reality with numerous exercises, or even verify the correct results simply with footage of the experiments. QR Codes can also be used for offering optional help with the critical phases of harder and more complex assignments to students with less progress. The QR Code can direct them to a site where a graphic picture, a leading question, a quote of the applicable physical law, or footage of the experiment demonstrating a specific phase of the solution might be of assistance.

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Alexander Struck (Rhein-Waal University of Applied Sciences, Kleve, Germany):

Making and using video introductions for physics lab experiments

Lab experiments are an important part of teaching undergraduate physics at universities, in particular in subsidiary courses for engineering students. Commonly a lack of preparation time and/or motivation of many students can be observed, mostly affecting the ability to successfully perform the given experiment. We are presenting our approach of providing a video tutorial as guidance for the lab experiments in addition to classical text introductions. Nowadays students are familiar with watching short videos for any instruction at any location by using their mobile phones or computers. Our approach includes video tutorials that have been created by science communication students, who have only recently completed the labs and are moreover proficient with the use of video equipment. This adds an interdisciplinary aspect, and the advanced students serve as role models for other students. Furthermore, the videos give an access to experimental details for large student groups.

Ildikó Szatmáry-Bajkó (Szent István Gimnázium, Budapest, Hungary):

Handicraft and aesthetic experience in teaching chaos physics

Our aim is to raise awareness of the importance of getting acquainted with chaos physics in the frame of teaching modern physics. We would like to come up with some ideas for this, this time our topic is handicraft. Apart from raising interest, experiencing the joy of creating something may help students understand and deepen their knowledge of chaos physics.

Ákos Szeidemann, Áron Csaba Bodor, Marcell Juhász (Eötvös József Secondary School, Tata, Hungary):

Observation of the drying process in secondary school

Some years ago we built a solar dryer during an extracurricular class. Although we had no chance to analyse the drying procedure itself, with the help of students, we did some experiments and measurements associated with the device. An electric dryer was used to eliminate the environmental effects in order to observe the drying process. This way we made quantitative statements about it. We made a series of measurements that are comprehensible for high school students attending these extracurricular classes. We measured mass reduction due to loss of water as a function of time for some fruits. We compared these with values found in the literature. The results resembled the evaporation of a fluid of two constituents. In order to make this procedure understood by high school students we derived a model of it.

Zsolt Szigetlaki (Intellisense Zrt., Budapest, Hungary):

Computer-aided measurement and simulation in science education

Digital transformation of education is an inevitable and a clearly positive process. Computer usage in science education is particularly useful, as it opens new possibilities for teachers in knowledge transfer and experimentation as well as helps students to gain deeper understanding of science problems. This session will elaborate on cutting-edge education technology through a number of practical examples.

István Szittyai* (László Németh High and Grammar School, Hódmezővásárhely, Hungary):

Speed-mania: measuring velocity in secondary school

The concept of velocity is not so easy for secondary school students, but when we wanted to measure, we realized a further difficulties: how hard it is to measure velocity! Fortunately, digital-electronic devices are available now for innovative teachers and their students too, such as photogates with data loggers, distance-measuring ultrasonic sensors, or laser distance meters. These equipments allow us to measure velocity of objects in kinematic-dynamic experiments quite accurately. Moreover, some study group project will be shown which are about how the students measured the speed of sound in gases and the speed of light in several liquids – directly.

Anikó Márta Tasnádi* (Karinthy Frigyes Gimnázium, Budapest, Hungary):

From Heat Pumps to Hurricanes: Application of Thermodynamics in Secondary Education

The students' decreasing interest in physics is a major problem of physics teaching. Physics teachers worldwide seek the possibility for the change of this tendency. According to our opinion the investigation of the physics of the devices used in everyday life might be a good tool for this. Thermodynamics gives a lot of opportunity to raise the interest of students. The basis of the operation of many appliances and machines, (e.g.: refrigerator, air conditioner, tumble dryer, engines of cars etc.) and even a natural phenomenon, the hurricane can be discussed by some kind of thermodynamic cycles. Therefore a new curriculum was elaborated for teaching the basis of thermodynamics with particular regard to its technical applications. The students worked in groups and researched different devices, and finally gave short lectures on their results. In the present contribution the experiences gained during the teaching of this short new curriculum will be discussed on the basis of the assessment of the students and the interviews held afterwards.

Tamás Tasnádi (Budapest University of Technology and Economics, Budapest, Hungary):

Puzzling problems on gravity

Although Newton's gravitational law is simple to state, it leads to a rich diversity of motions ranging from free fall and parabolic projectile motion via elliptic, hyperbolic celestial orbits to chaotic dynamics. The tools applied in these problems are also versatile; conservation laws, geometric considerations, rotating reference frames, clever approximations, or higher mathematical methods (calculus) are all used. In this contribution a bunch of puzzling problems on gravity is presented with the basic ideas of their solutions. Each problem requires a kind of unique, individual method and each solution teaches us something new. Some of the results are surprising. Most of the presented problems are used in the preparation for the International Physics Olympiad, either in the classes or in the selection competitions, and their solutions are attainable by elementary, secondary school methods.

Jessica Tee, Erik Stengler (University of the West of England, Bristol, United Kingdom):

Teaching physics and astronomy and inspiring further study at the Science Centre At-Bristol, UK

It is often assumed that science centres help to back up pupils' existing knowledge as well as inspire interest in curricular Physics and Astronomy and topics not covered in the school, and then, in turn, result in increased further study in these subjects. Recent reports show a record increase in the number of students studying these subjects at the level of Higher Education. An

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investigation was carried out to collect evidence that science centres can have a positive effect on young children's formal education and beyond. Quantitative and qualitative methods were used to examine whether the science centre At-Bristol's exhibitions and planetarium show align with the current UK curriculum guidelines in Physics and Astronomy and the point of view of a science centre educator and a teacher on whether they can increase further uptake of these particular subjects later on. The evidence gathered showed a positive correlation between science centres, the curricular content and beyond.

Tünde Tóthné Juhász* (Karinthy Frigyes Gimnázium, Budapest, Hungary):

A computer simulation based teaching experiment

In the academic year 2014-2015 several schools from different parts of Hungary took part in a teaching experiment. The experiment was based on a computer simulation program (FIZIKA) created by Intellisense Zrt. The program can be used to simulate mechanics problems, and has an option which enables the user to visualise and analyse different graphs of the simulated motions quantitatively. In the teaching experiment we wanted to investigate the efficiency of using this program. We wanted to see whether graphical visualisation and analysing helps students to improve their creativity and to develop a better understanding of the basic concepts and theorems of mechanics.

József Vanyó, József Vida (Eszterházy Károly College, Eger, Hungary):

The Magic Tower of Eger

In 2006, the museum activities of the Eszterházy Károly College were broadened by experimental science demonstrations and, thanks to a new planetarium projector, planetarium programs. The improvement did not stop here though; a new Scientific Center called The Magic Tower was established, operating on four floors and developing ever since. The directorate of The Magic Tower, besides being informative on natural science set out new goals, including the training of teachers and drawing the youth's attention to natural science. The presentation covers our results so far, the devices necessary to achieve these goals, and our future plans as well.

Zsolt Vicze* (Balassi Bálint Grammar School, Budapest, Hungary):

Implementing inquiry in teaching electricity

Recently there are several studies and projects which use the inquiry-based learning to develop education. In this method the 5E model is mostly used: engage, explore, explain, elaborate, evaluate. An experimental method is developed to implement this process in teaching electric circuits. The students can see a "black box" with four plugs and they can make measurements with different connections for find out what is in the box (they know there is some combination of resistors). The whole process can be done by hands-on activities or by using modelling software. In this activity the students have to understand the measurements and have to make a model about the inside of the box and they should make testable predictions.

Máté Vigh (Eötvös Loránd University, Institute of Physics, Budapest, Hungary):

Funny motions of billiard balls, rubber balls and hockey pucks

In advanced textbooks about mechanics one can frequently see detailed theoretical description of the motion of balls rolling and slipping on a surface. Even Coriolis, the well-known French physicist found this topic so interesting that he wrote a book about the funny motion of billiard

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balls. In this presentation we want to show some beautiful examples of these kind of motions and try to answer questions like: 'What is the Coriolis massé shot?', 'What will stop first in the case of a rotating and translating ice hockey puck: the rotation or the translational motion?', 'Why does the golf ball dance out from the hole so often?'. The explanations rely on only high school physics, without using hard mathematics.

Alpár István Vita Vörös, Zsuzsa Sárközi (Apáczai Csere János High School, Cluj-Napoca, Romania):

Promoting environmental physics issues in science centers and at science-events

Science teaching in general is problematic because the abstractness of content of sciences taught at school makes it irrelevant. We consider that environmental physics issues could be interesting for students but these are not included in the school curriculum. Organizing extracurricular physics events is of great importance as it presents aspects that are related to everyday life and environment. We intend to make an overview of experiments related to environmental physics displayed throughout different European science centres. We present experiments related to this topic performed during the annual event "Saturday of experiments" organized at the Babes-Bolyai University – tsunamis, weather fronts, cyclones – and make suggestions for the possibility to display at science centres without the help of an animator. Finally we make proposals for new hands-on physics experiments to present environmental physics issues in science centres.

Csilla Wiener (Eötvös Loránd University, Institute of Physics, Budapest, Hungary):

On the first-year students of the physics teacher training programme at ELTE

Eötvös Loránd University (ELTE) is the most prestigious university in Hungary in the field of teacher training. However, since there is no entrance exam (students are admitted to the university based on primarily the results of their high school final exams), many physics students lack even an average level knowledge of high school physics. To overcome this problem new courses were introduced to the physics teacher training program, where undergraduate physics is taught. Still, experience has shown that these courses are only efficient for approximately 20% of the students. It seems that besides the absence of physics knowledge, students also have problems with some basic skills like reading comprehension, study skills, and note-taking skills. So can we say, that there is a gap between high school physics and university requirements? It will be discussed in this contribution.