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CONTENT

WELCOME

Dear participants,

After two years and a half, we meet again at the **2nd South Eastern European Meeting on Physics Education (SEEMPE) 2015.** Welcome to Slovenia, Faculty of Education, University of Ljubljana. The intention of SEEMPE is to bring together educators, researchers and scientists from neighbouring countries in the south Eastern region of Europe working on physics education. However, many researchers come also from other European countries. We are very happy that they find this meeting interesting as well. The aim of the meeting is to present the results of the research in physics education, to exchange research experiences and to discuss various problems, possible initiatives for projects and to discuss experiences with on-going or finished projects.

Physics education research and physics education in general is becoming more and more important, as the authorities are aware, that future needs scientists. Therefore, our mission is to provide an appropriate school environment that encourages students for studying science.

Here we have to repeat few experiences from the first meeting. Education is often considered as an art and the research in science education is not valued in the same way as other domains from the majority of physicists. However, results of physics education research have severely influenced teaching and learning processes at different cognitive level and in different institutions of formal and informal education. The way of teaching, the understanding of the teaching intervention effect on students' knowledge, students' conceptual understanding, misconceptions, and cognitive abilities of students to understand difficult or easy concepts in physics are playing more and more important role in transfer of knowledge to students.

As the whole "know how" with respect to SEEMPE was already in Ljubljana, we have volunteered to organize the second meeting in rather short notice. Several people responded to the call and more than 40 people from Croatia, Serbia, Bosnia and Hercegovina, Slovakia, Poland, Germany, Austria, Italy, Turkey and Slovenia has come to share the ideas and report on research results. It is an indication that our part of Europe is very active within this research field. We are looking forward to have a scientifically strong and interesting meeting, which would also result in future collaborations.

Mojca Čepič, chair of the meeting

Program - Monday, 2.2.2015

	presenting author	title	chair
8:50 - 9:00	**opening**		
9:00 - 9:30	*Eugenia Etkina*	What is Content Knowledge for Teaching Physics and How Can We Assess it?	Leopold Mathelitsch
9:30 - 10:00	*Angela Foesel*	Use your head – in football and physics education	
10:00 - 10:20	*Zalkida Hadžibegović*	Engineering freshmen understanding of atmospheric pressure: The 5E learning model effects	
10:20—10:40	*Bayram Akarsu*	Escaping Bear and Snail: How Ready is Engineering Students For Puzzle-Based Learning	
10:40 - 11:00	*Gorazd Planinšič*	Framework for using modern devices in an introductory physics course	
11:00 - 11:30	**coffee break + poster session**		
11:30 - 12:30	*Dagmara Sokolowska, Daniel Dziob, Justyna Nowak, Aleksandra Wańczyk, Mateusz Wojtaszek, Witold Zawadzki, Grzegorz Brzezinka*	Simple experiments for enhancement of pupils' curiosity about science	Mojca Čepič
12:30 - 13:30	**lunch**		
13:30 - 14:00	*Nataša Vaupotič*	Labyrinthine-like wrinkled surfaces in liquid crystalline free standing film	Maja Planinić
14:00 - 14:20	*Mojca Čepič*	Introduction of Current Scientific Results into Education: Metastudy and Towards a Theoretical Framework	
14:20 - 14:40	*Tomaž Kranjc*	Is the equivalence principle to be included in physics instruction for non-physicists?	
14:40 - 15:00	*Bor Gregorčič*	The added value of the interactive whiteboard	
15:00 - 15:20	*Jaka Banko*	Problem solving approach to geometric optics – applying theory to practice through primary school students' hands-on experience	
15:20 - 15:40	*Nada Razpet*	Analysis of children's sketches	
15:40 - 16:10	**coffee break + poster session**		
16:10 - 16:40	*Lana Ivanjek*	University students' difficulties with atomic emission spectra	Zalkida Hadžibegović
16:40 - 17:00	*Maja Planinić*	Building stronger student knowledge – the case of graphs	
17:00 - 17:20	*Ana Sušac*	Student understanding of physical measurement	
17:20 - 17:40	*Katarina Jeličić*	Student difficulties with electromagnetic induction and analysis of a research instrument	
17:40 - 18:00	*Jelena Radovanović*	Results of a delayed transfer test of students' understanding of buoyant force and related phenomena stemming from two different learning experiences	
19:30-	**Dinner**		

Program - Tuesday, 3.2.2015

	presenting author	title	chair
9:00 - 9:30	*Claudia Haagen*	A Design-Based-Research Project on Teaching Colours in Introductory Optics in Year 8	Gorazd Planinšič
9:30 - 9:50	*Marian Kireš*	The inquiry skills required for everyday phenomenon investigation	
9:50 - 10:20	*Marisa Michellini*	Developing formal thinking in learning progression research approaches and modern physics proposals	
10:20 - 10:40	*Zuccarni Giacomo*	University Students on Incompatibility of Observables in Quantum Mechanics	
10:40 - 11:00	*Alberto Stefanel*	Exploration of students' ideas on superconductivity	
11:00 - 11:30	**coffee break + poster session**		
11:30 - 12:30	*Jerneja Pavlin*	Hands-on experiments with hydrogels	Mojca Čepič
12:30 - 13:30	**lunch**		
13:30 - 14:00	*Dagmara Sokolowska*	Assessment opportunities in inquiry-based learning	Eugenia Etkina
14:00 - 14:30	*Maja Stojanović*	Comparison of the efficiency of three teaching methods in physics using the cognitive load	
14:30 - 14:50	*Ivica Aviani*	Influence of two different methods for solving free-body diagrams on students' ability to identify forces and apply Newton's laws	
14:50 - 15:10	*Nataša Erceg*	Probing students' conceptual knowledge of satellite motion by use of diagram	
15:10 - 15:30	*Sergej Faletič*	The Klein-Gordon string - a versatile system I've never heard of before	
15:10 - 15:40	**coffee break + discussion of future perspectives**		
15:40 -	**closing**		

INVITED SPEAKERS

1. What is Content Knowledge for Teaching Physics and How Can We Assess it?
Eugenia Etkina, Lane Seely, Stamatis Vokos

2. Use your head – in football and physics education
Angela Fősel

3. A Design-Based-Research Project on Teaching Colours in Introductory Optics in Year 8
Claudia Haagen-Schützenhöfer

4. University students' difficulties with atomic emission spectra
Lana Ivanjek, Peter Shaffer, Lillian McDermott, Maja Planinić

5. Developing formal thinking in learning progression research approaches and modern physics proposals
Marisa Michelini

6. Assessment opportunities in inquiry-based learning
Dagmara Sokolowska, Odilla Finlayson, Deirdre McCabe, Pawel Bernard

7. Comparison of the efficiency of three teaching methods in physics using the cognitive load
Maja Stojanović, Branka Radulović

8. Labyrinthine-like wrinkled surfaces in liquid crystalline free standing films
Nataša Vaupotič

1. What is Content Knowledge for Teaching Physics and How Can We Assess it?

Eugenia Etkina[1], Lane Seely[2], and Stamatis Vokos[2]

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This talk will share our work on the development of a theoretical framework for Content Knowledge for Teaching Energy (CKT-E) in high school physics. Specifically, it will describe how the new construct of Content Knowledge for Teaching of specific content is different from the construct of PCK - Pedagogical Content Knowledge and how we can assess this knowledge when observing teachers In the classroom and through using paper-and-pencil instruments. Three universities (Rutgers, Seattle Pacific and University of Maine) and Educational Testing Service join their efforts together in this collaborative project.

2. Use your head – in football and physics education

Angela Fösel

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Including sports issues in physics education offers an opportunity to increase students' interest and motivation. Furthermore, it allows for taking into account the methodical and didactic ideas of 'active learning', which here means learning by and in motion. Students can perform athletic activities, they can measure physical parameters of their own movements, and they can analyse the resulting data. However there are a wide variety of possibilities to measure parameters and analyse data concerning the athletic activities of real sportspersons. In any case, there is a definite necessity to develop and apply models in order to interpret and understand the complex human limb movements. This active modelling helps students attain knowledge regarding problem solving. Lastly, by measuring and explaining sports activities, fundamental concepts of physics can be taught.

Football is the one of the most popular sports in many countries, which means that a football-themed physical discussion usually arouses great interest. This presumably accounts for the fact that a wide range of (popular) science literature, as well as technical and subject-didactic articles have been published on this subject. Apart from extensive works on football in its entirety, some partial aspects have been singled out for closer scrutiny, such as unexpected trajectories of balls (curling crosses) which impressively show the Magnus effect, the high ratio of coincidence in football results which lends itself to statistical evaluation and the goalie's (and the penalty-taker's) anxiety at the penalty kick, which can be convincingly explained with kinematics. Another important component of the game, namely headers, have not yet been analysed as diligently, even though the question of how dangerous a header really is relates directly to the determination of the forces and acceleration involved. In this talk, we will show that headers may enrich physics education experimentally as well as theoretically. Especially, we would like to focus on and present the examination of the interaction of football and head from various different viewpoints. On the one hand, we introduce a wide array of experimental approaches, from simple experiments to video analysis and data acquisition with acceleration sensors. We show the good agreement between data from video-camera and from sensor-based data logging. We also point out that data logging and analysis concerning real situations within a football match are much more difficult than experimental set-ups in laboratory.

We attempt to explain the data by using theoretical models of varying complexity. For instance, simple models may assume certain parameters like maximum force. When applying dynamical models even time-based sequence of action could be simulated.

Finally, health aspects with regards to headers are discussed, as especially young players are at a particular risk in this respect and should be fully aware of this fact.

3. A Design-Based-Research Project on Teaching Colours in Introductory Optics in Year 8

Claudia Haagen-Schützenhöfer

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We perceive our environment mainly through visual stimuli. Seeing colours is one eminent part of visual perception. Understanding the phenomenon of coloured bodies based on adequate physical concepts poses a big challenge for students in initial optic courses (Martinez-Borreguero et al., 2013). A number of students' alternative conceptions about colour, which hinder the understanding of colour phenomena, are known from physics education research. One prerequisite for understanding (geometrical) optics on a basic level is the idea that light emitted from or reflected by an object needs to enter the eye of the observer in order to produce a visible sensation (deHosson et al., 2007; Guesne, 1985). Feher and Meyer (Feher et al., 1992) summarize the following ideas as the most frequent categories of students' conceptions on the colour of illuminated objects: (1) the coloured light mixes with the colour of the object, (2) coloured light is dark and makes objects appear darker, (3) coloured light gives its colour to the object, (4) coloured light has no effect on the appearance of objects. What makes the situation of instruction even more difficult in initial physics instruction in Austria is that the physics curriculum of year 8 contains colour phenomena as part of geometrical optics. The wave nature of light is, however, not part of year 8, but is first brought up in year 10. Consequently, the teaching of colour phenomena is restricted to reconstructions of body colours not including the wave aspect of light. Usually, Austrian students learn about two phenomena relevant for colour phenomena, namely additive and subtractive colour mixing. What students mostly retain and use in any situation if appropriate or not – are the mixing rules they know from their water colour boxes. This contribution presents research based teaching materials developed and evaluated in a Design Based Research Project. In order to support learning processes we based the teaching materials about body colour on real phenomena and reconstructed the explanation with the processes of selective absorption and emission of light. Several easy experiments, which are supposed to help students to relate body colour to processes of selective absorption and emission, were developed. In the course of these easy experiments, students are instructed to observe and determine the paths of light from a light source via the body to the observer.

References

Feher, E. & Meyer, K.R. (1992). Children's conceptions of color. Journal of research in Science Teaching, 29(5), 505–520. Guesne, E. (1985): Light. In: R. Driver, E. Guesne und A. Tiberghien (Hg.): Children's ideas in science: Open University Press, S. 10–32.

Hosson C. de, Kaminski W. (2007): Historical Controversy as an Educational Tool: Evaluating elements of a teaching–learning sequence conducted with the text "Dialogue on the Ways that Vision Operates". International Journal of Science Education;29(5):617–642.

Martinez-Borreguero, G., Pérez-Rodríguez, Á.L., Suero-López, M.I. & Pardo-Fernández, P.J. (2013). Detection of Misconceptions about Colour and an Experimentally Tested Proposal to Combat them. International Journal of Science Education, 35(8), 1299–1324.

4. University students' difficulties with atomic emission spectra

Lana Ivanjek[1], Peter Shaffer[2], Lillian McDermott[2], Maja Planinić[1]

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Physics education research is still mostly focused on student understanding of basic topics from classical physics, with less emphasis on topics from modern physics. Examples of such a topic are line spectra. It is important that students develop good understanding of spectra as a prerequisite for understanding of quantum mechanics, as well as astrophysics. The structure and formation of spectra are a part of university and secondary school curricula both in Croatia and in the United States. Systematic investigation of student understanding of atomic spectra was conducted among 1000 science majors in introductory physics courses at University of Zagreb, Croatia and University of Washington, USA. The research had two focuses: 1) to probe the extent to which university students are able to relate the wavelength of spectral lines to the transitions of electrons between energy levels in an atom, and 2) to probe the extent to which students recognize the conditions under which discrete line spectra are (or are not) formed.

The results indicate low student understanding of the process of line spectrum formation. When asked about the connection between energy levels and spectral lines, many students did not seem to recognize that each spectral line is a result of a transition of an electron between two energy levels. Difficulties with the understanding of the role of the experimental setup in formation of a line spectrum were also encountered. A question that probed that aspect of student understanding was constructed and administered to students. Only between 20 % and 30 % of the students recognized that the type of the light source is critical for the formation of a line spectrum. Students were often treating a prism as if it always yielded a continuous spectrum, treating spectral lines as if they were always visible, and most of them were confusing discrete line spectra with diffraction patterns. Identification and analysis of student difficulties guided the design of a set of new instructional materials, tutorials, to supplement instruction in a standard calculus-based physics course. An online spectra application for homework use was also designed. The posttest results showed that some of the student difficulties persisted even after instruction, and that there is more space for the further improvement of instruction materials.

Findings from the research questions will be presented, and students' most frequent reasoning difficulties will be discussed. Students' posttest results and the examples from the tutorial will also be presented and discussed.

5. Developing formal thinking in learning progression research approaches and modern physics proposals

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In the framework of the Model of Educational Reconstruction we study the development of formal thinking starting from phenomena exploration. 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. The research is not only limited to those that function in practice, but integrate learning processes analysis. Empirical data analysis is carried out on three main research problems: 1) individual common sense perspective with which different phenomena are viewed and idea organization, in order to activate modeling perspective in phenomena interpretation, 2) the exploration of spontaneous reasoning and its evolution in relation to a series of problematic stimuli in specific situations, in order to formulate activity proposals, 3) recognizing the modalities for overcoming conceptual knots in the learning environment in order to reproduce these conditions. We study three main aspects: 1) object-models role in favoring the student's first interpretative steps, 2) ICT role in overcoming conceptual knots, 3) developing theoretical thought in an educational path concerning quantum mechanics.

Modern physics in secondary school is a challenge, which involve our research work since from 2006 in finding reasoning trajectory able to suggest learning path proposals based on experimented proposals of active learning. After a presentation of our research approach and the learning progression perspective into the research with some examples, the modern physics proposals developed will presented, focusing on the characteristics of quantum mechanics teaching/learning path.

6. Assessment opportunities in inquiry-based learning

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One of the most sought-after skills, naturally developed through inquiry, are the reasoning skills (formulation of research questions, formulation of hypotheses, planning investigation, presenting and explaining ideas, overcoming difficulties) and performance abilities (conducting the experiments, co-operating). Moreover, during the inquiry lessons the engagement in brain storming and discussions, as well as the competences in use of different representations can be developed. All of them give a teacher many opportunities to assess the students individually or in groups, providing them with an immediate feedback during the activities or with a written assessment after the classes.

SAILS project has been founded by EU under the 7th Framework Programme to support teachers in adopting inquiry-based science education (IBSE) at the second level of schooling (students aged 12-18 years) across Europe by providing them with inquiry-base didactic material supplemented with the assessment instruments.

During the talk an assessment strategy developed in SAILS project will be presented together with the examples of its implementation.

Acknowledgment

This work is supported by the SAILS research project (SIS.2011.2.2.1-1, grant agreement 289085), which received funding from the European Union under the Seventh Framework Program.

7. Comparison of the efficiency of three teaching methods in physics using the cognitive load

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Modern didactic trends have the tendency to shift the focus from traditional learning to new teaching methods, which show the greater efficiency in the students' understanding of the content. We examined how a particular form of learning affects the mental effort of students while learning the new concepts. Three methods were studied: the multimedia, the method of using experiments and the traditional method. Testing of the cognitive load determines the changes of teaching methods, and thus the direction of their development.

This study included 187 second grade students in high school (gymnasium – science and mathematics direction) in Novi Sad. Data were collected using a cognitive test designed for this study. Data processing was done using the descriptive methods, test, Wilcoxon t-test and ANOVA.

The main conclusions of this study are that there is a causal link between the choice of teaching methods and the achievements, i.e., the cognitive load of students. The results suggest that the students who received instructions using experiments have obtained greater achievement and subjectively showed less cognitive load, than the students who received instructions using other two methods. Therefore, the results obtained indicate that the teaching method using experiments is more efficient than other two methods, because it causes less cognitive load, which increases the likelihood that the resulting information is processed into long-term memory.

8. Labyrinthine-like wrinkled surfaces in liquid crystalline free standing films

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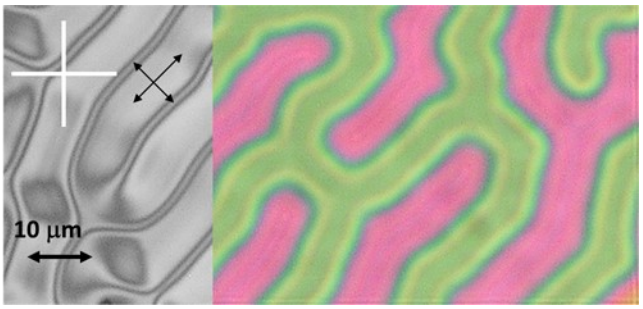
Liquid crystals are materials which, next to the crystalline, isotropic liquid and gaseous phase, also have a liquid phase which possess some orientational order of the constituent molecules. This phase flows like liquids, but its physical properties are direction dependent (anisotropic), which is characteristic for crystals. Because of that such materials are called liquid crystals and the phase a liquid crystalline phase. Liquid crystals present a new polygon for experiments in the secondary school and at the undergraduate university level and a set of liquid crystals experiments can present a file rouge through several topics in physics education [1,2].

Although liquid crystals were discovered at the end of the 19th century, they are still a topic of a current research. In the talk I will present a recent study of thin free standing films (like the one we make when we want to blow a bubble) made of liquid crystalline material in which, upon lowering the temperature, the surface wrinkles, which means that the surface is not the minimal possible [3]. A periodic modulation of the film thickness is obtained and a labyrinthine structure of crests and valleys is formed. The thickness instability occurs spontaneously at a threshold temperature within the liquid crystalline phase. Labyrinths were observed both in thin and thick films. The width of the labyrinthine path depends on the temperature and the thickness of the film.

Comparing the textures observed in the reflected light (see figure, right) and the light transmitted between crossed polarisers (see figure, left) it is found that the film thickness is coupled to the spatial variation of the molecular orientation. In the regions with thickness gradient the molecular orientation is uniform and on the top of the hills or bottom of the valleys it rotates by 180 degrees. The observed phenomenon is associated to the difference in the mass density at the surface and in the bulk. Theoretical estimates show that at a certain temperature the system reduces the free energy by enlarging the sloped regions more than it pays for the formation or the defects associated with increasing the sloped areas.



In the talk I will explain how simple, but ingenious experiments enable determination the structure of the film and how simple theoretical considerations can help in confirming or discarding the possible models of the structure.

References

[1] J. Pavlin, N. Vaupotič and M. Čepič, Eur. J. Phys. 34, 745 (2013).
[2] J. Pavlin, N. Vaupotič and M. Čepič, Eur. J. Phys. 34, 331 (2013).
[3] D. Pociecha, E. Gorecka, N. Vaupotič, M. Čepič and J. Mieczkowski, Phys. Rev. Lett. 95, 207801 (2005).

ORAL CONTRIBUTIONS

1. Escaping Bear and Snail: How Ready is Engineering Students For Puzzle-Based Learning?
Bayram Akarsu
2. Influence of two different methods for solving free-body diagrams on students' ability to identify forces and apply Newton's laws
Ivica Aviani, Nataša Erceg, V. Mešić
3. Problem solving approach to geometric optics – applying theory to practice through primary school students' hands-on experience
Jaka Banko
4. Introduction of Current Scientific Results into Education: Metastudy and Towards a Theoretical Framework
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5. Probing students' conceptual knowledge of satellite motion by use of diagram
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18. University Students on Incompatibility of Observables in Quantum Mechanics
Giacomo Zuccarini, Marisa Michelini

1. Escaping Bear and Snail: How Ready is Engineering Students For Puzzle-Based Learning?

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Critical thinking and problem solving abilities are accepted as one of the most important abilities in science education. This study explores engineering students' problem solving skills in college. In addition, their critical thinking and puzzle-based learning abilities were explored. Data were collected from 139 freshman students enrolled in Mechatronic, Civil, Electrical and Electronics, Biomedical, Industrial, Computer and Metallurgical and Materials engineering departments during Spring 2013 semester. Participants were in the second semester of their first year in college. 67 % (N= 94) of them were male and 33 % (N=46) were female. Findings revealed that most of the students are lack of critical thinking and problem solving skills and are not ready for puzzle-based learning activities.

References

Alexander, W.A. (2004). *Workplace skills and the skills gaps related to employee critical thinking ability and science education curriculum.* Doctoral dissertation, The Ohio State University, UMI No. 3144834.

Bailin, S. (2002). Critical Thinking and Science Education. *Science & Education,* 11, 361–375.

Becker, D.E. (2007). *The effect of patient simulation on the critical thinking of advanced practice nursing students.* Doctoral dissertation, Drexel University, UMI No. 3259372.

Bricker, L.A. & Bell, P. (2008). Conceptualizations of argumentation from science studies and the learning sciences and their implications for the practices of science education. Retrieved from http://www.interscience.wiley.com, doi: 10.1002/sce.20278.

Burns, E. (2009). The use of science inquiry and its effect on critical thinking skills and dispositions in third grade students. Doctoral dissertation, Loyola University Chicago, UMI No. 3367974.

Byrne, M.S. & Johnstone, A.H. (1987). Critical thinking and science education. *Studies in Higher Education,* 12(3), 325-339.

Cho, K. & Jonassen, D.H. (2002). The effects of argumentation scaffolds on argumentation and problem solving. *Educational Technology Research and Development*, *50*(3), 5–22.

Clarke, K. C. (2010). A science, engineering and technology (SET) approach improves science process skills in 4-H animal science participants. *Journal of Extension*, *48*(1), 1-4.

Derwin, E.B. (2008). *Critical thinking in online vs. face-to-face higher education.* Doctoral dissertation, Fielding Graduate University, UMI No. 3343844.

Duschl, R. (2008). Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of research in education*, *32*(1), 268-291.

Duschl, R. A., & Osborne, J. (2002). Supporting and promoting argumentation discourse in science education. *Studies in Science Education, 38*, 39-72.

Erduran, S., & Jiménez-Aleixandre, M. P. (Eds.). (2008). *Argumentation in science education: Perspectives from classroom-based research* (Vol. 35). Springer.

Erduran, S., Simon, S. & Osborne, J. (2004). Tapping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education*, *88*(6), 915–933.

Driver, R., Newton, P. & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, 84, 287-312.

German, N.A. (2008). *Assessment of critical thinking skills among undergraduate athletic training students.* Doctoral dissertation, North Dakota State University, UMI No. 3335160.

Goh, W.W.L. (2008). *Dialogic argumentation as a path to enhancing individual argumentive reasoning in academically disadvantaged 8th-graders*. Doctoral dissertation, Columbia University, UMI No. 3305223.

Halpern, D.F. (1999). Teaching for critical thinking: Helping college students develop the skills and dispositions of a critical thinker. *New Directions for Teaching and Learning,* 80, 69–74.

Harlow, D.B. & Otero, V.K. (2004). An examination of children's scientific argumentation. *Physics Education Research Conference Proceedings,* 720, 145-148.

Hewson, M.G. & Ogunniyi, M.B. (2011). Argumentation-teaching as a method to introduce indigenous knowledge into science classrooms: opportunities and challenges. *Cultural Studies of Science Education, 6,* 679–692, doi: 10.1007/s11422-010-9303-5.

Ingram, M. (2008). *Critical thinking in nursing: experience vs. education.* Doctoral dissertation, University of Phoenix, UMI No. 3304800.

Jiménez-Aleixandre, M. P., & Erduran, S. (2007). Argumentation in science education: An overview. In *Argumentation in science education* (pp. 3-27). Springer Netherlands.

Kanik, F. (2010). *In partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Educational Sciences.* Doctoral dissertation, Middle East Technical University, Ankara.

Kıngır, S., Geban, Ö. & Günel, M. (2011). Students' ideas about the implementation of the argumentation based science inquiry approach in their chemistry course. *Selçuk University Journal of Ahmet Kelesoglu Education Faculty (AKEF),* 32, 15-28.

Kim, K., Sharma, P., Land, S.M. & Furlong, K.P. (2012). Effects of active learning on enhancing student critical thinking in an undergraduate general science course. *Innovative Higher Education,* 38, 223–235.

Kuhn, D. (1991). *The Skills of Argument*. Cambridge University Press.

Kuhn, D. (2010). Teaching and learning science as argument. *Science Education*, *94*(5), 810-824.

2. Influence of two different methods for solving free-body diagrams on students' ability to identify forces and apply Newton's laws

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In most physics courses vector calculus is carried out by resolving the forces into components and then summing up the components of the same direction. Although this procedure facilitates the calculation, it potentially leads to the misconception that the components are also some real forces. In addition, the procedure is not entirely in accord with the concepts of the Newton's laws which state that the motion of the body is determined by the vector sum of the forces. The question arises: is the direct vector method or application of the polygon rule for vector addition more successful in teaching mechanics?

In this study, we have developed an instrument to measure students' ability to identify real forces in different diagrams. Using this instrument we made an initial study of the effectiveness of the two different problem solving methods. Our test, consisting of 12 items, was administered to two groups of first-year physics students at Rijeka (RG) (n = 27) and Split (SG) (n = 25) university, after the "concept of force" had been covered in class. Afterwards, both groups exercised additional force diagrams tasks for a period of two class hours. The only difference was that RG used the polygon rule and SG the vector components method. Post test showed a shift in the average rate of correct responses which was significantly larger for RG. Based on these initial results we formulate the working hypothesis for the future investigation: If we apply the teaching method where the force diagrams are solved by using the polygon rule, we foster the students' ability to identify real forces and we improve their understanding of Newton's laws.

3. Problem solving approach to geometric optics – applying theory to practice through primary school students' hands-on experience

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Wax lenses are an inexpensive way for students to explore the basics of geometrical optics through individual experimental work or group work. Making lenses is suitable for school project days, science days, fairs or other similar events. Home-made lenses allow teacher to use problem solving approach to teaching. Students can design their own experiments, make lenses, construct optical instruments and test their hypotheses which would explain the phenomenon or solve the problem. The flexibility of the material from which lenses are made allows students to change the radius of the lens and hence adjust the focal length. Lenses also have a motivational value (different colours, sizes).

4. Introduction of Current Scientific Results into Education: Metastudy and Towards a Theoretical Framework

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Students consider physics as boring, abstract and detached from everyday life, and they are not aware of ongoing research. However, our society and almost all of its welfare is based on research results, where applicative potentials were recognized. The society being thoroughly familiar with current research is rather specific. Researchers are usually not involved in education except at graduate levels, and usually they do not feel a desire or an obligation to transfer the new knowledge to younger students or to the lay public. Nevertheless, this step toward non trained researchers is crucial in order to get a support for a research from a general citizen and a taxpayer and to increase a motivation of best students to pursue scientific careers.

We have recently developed a module that has introduced current research results on liquid crystals into education [1]. The module consists of lectures and laboratory work in chemistry and physics. Several problems have arisen during the development of the module, for example: goals and an expected conceptual level of understanding had to be defined; a necessary preliminary knowledge of students had to be determined; most appropriate methods for teaching novel concepts had to be chosen; the research topic had to "translate" from professional language of researchers to semi - several experiments for illustrations and support for conceptual understanding; tests for assessment had to be developed and several other smaller problems had to be solved. Introduction of new research results into education is an interesting and a difficult research problem by itself.

Inspired by our experiences during an introduction of current research results into education for a case of liquid crystals, we tried to find similarities or differences in existing approaches to a transfer of new scientific knowledge into education. There were not many reports on introductions of new topics. Reports mainly considered designs of new laboratory experiment (in advanced optics and similar), only few modules were found (on tribology, semiconductors), sometimes topics aimed for teachers are presented (nanotechnology, superconductors) and only one example on semiconductors was found where a module was developed and evaluated [2].

This contribution reports on results of this metastudy and we will share detailed results on
(a) Considerations and steps that were used at introduction of a topic »liquid crystals« to education at al levels [1].
(b) Metastudy of reports on introduction of other topics: superconductivity, tribology, semiconductors, advanced optics and other modern topics.

Based on this data, we shall suggest a pilot theoretical framework for introduction of current research results into education with an emphasis on physics. The theoretical framework will consists of criteria for the choice of a modern topic, for determination of teaching goals, of prerequisites required from students and from teachers, a suggested procedure of module construction and implementation and finally, a suggestion for assessments of goals.

References

[1] J. Pavlin, N. Vaupotič, M. Čepič, Liquid crystals: a new topic in physics for undergraduates, Eur. J. Phys. 34, 745-761 (2013).
[2] A. Garcia-Carmona, A. M. Criado, Introduction to Semiconductor Physics in Secondary Education: Evaluation of a teaching sequence Int. J. Sc. Ed. 31, 2205–45 (2009).

5. Probing students' conceptual knowledge of satellite motion by use of diagram

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Regardless of wide use of satellites they are still often considered as “mysterious” objects, mostly because they travel in space where most of us have never been. So that developing an intuitive understanding of satellite motion remains out of our scope. That's probably why the dynamics of orbital motion proved to be conceptually difficult for students.

Being aware of these conceptual difficulties, many years after he published Principia, Newton wrote a popular text to explain the orbital motion of the Moon. In this paper he demonstrated the significance of the velocity of the satellite as equally responsible for the orbital motion as the attractive gravitational force of the Earth [1]. He discussed the trajectory of a cannon ball which was launched horizontally from the top of a high mountain and, which was attracted by the Earth gravity. If the launch speed was increased enough, the ball would start orbiting the Earth. Besides, the gravitational force is directed toward the center of the Earth so that the center of the circular satellite orbit and the center of Earth should match.

Two and half centuries later, students enter and leave the physics instruction with a wide variety of misconcepts about satellite motion. Many physics education researchers were aware of the importance of studying this topic which resulted in identification of many students’ misconceptions.

In our study [2], we investigated students’ ideas about possible satellite orbits. And we have concluded following: 1) Students tend to use the p-prim [3] "closer is stronger" instead of applying physics knowledge; 2) Regardless of their educational level and curricula, students in Croatia lack deep understanding of circular motion, gravitational force and first cosmic velocity. 3) The teachers considerably overestimate students’ abilities.

References

[1] I. Newton, A treatise of the system of the world (printed for F. Fayram, London, 1731).
[2] N. Erceg, I.Aviani, V.Mešić, Z. Kaliman and D. Kotnik-Karuza, Rev. Mex. Fis. E 60 (2014) 75.
[3] A. A. DiSessa, Cogn. Instr. 10 (1993) 105.

6. The Klein-Gordon string - a versatile system I've never heard of before

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I will introduce the so called Klein-Gordon string or braced string. In the discrete case, it consists of a system of many coupled oscillators. The wave equation for it is the Klein-Gordon equation, hence the name. The system displays dispersion and anisotropy. These properties are very valuable in a simple mechanical system which students can have concrete experience with. I will show how the dispersion property can be used to discuss group velocity, especially in the case of a single pulse. The question I hear often is, how come that on a medium with dispersion, not even the first crest travels with phase velocity. This system can answer it. The anisotropy property can be used to display the change in polarization from linear to elliptical and back, the feature displayed by light passing through birefringent materials, but rarely observable in mechanical waves, with which students can have concrete experiences. In the end, I will show that the system can also be used to reproduce the shapes of wavefunctions of quantum mechanical systems in a potential, such as exponential tails and tunnelling. With this we show that these properties are inherent to waves, and not a quantum phenomenon.

7. The added value of the interactive whiteboard

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As the interactive whiteboard (IWB) becomes more and more common in classrooms all over the world, there is an increasing need to use it productively for teaching different subjects, including physics. The IWB allows more than just projecting computer content onto a screen. Its touch sensitive surface allows manipulation of the on-screen content. If we want to use the IWB productively, we should engage students in activities where they are actively engaged in collaborative learning through investigative activities. We will present a qualitative study, where designed instructional materials were implemented in a high-school context. When developing the materials, we took into account the kinesthetic and collaborative affordances of the IWB to support student collaborative learning activities. We will explain how these affordances supported student engagement and communication among participants and present what we have found to be advantages and drawbacks of different kinds of IWB use in physics instruction from the students' and the teachers' point of view.

8. Engineering freshmen understanding of atmospheric pressure: The 5E learning model effects

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In this study are presented results based on the data collected in a learning sequence with main aim to explore students' understanding of atmospheric pressure. Also, this study investigates the effects of using 5E learning model and students' abilities to give their scientific explanations about some experiment outcomes they observed. The study participants were a group of 40 engineering freshmen at one public university in Bosnia and Herzegovina. The General Physics course syllabus was realized with them mostly on traditional teaching-learning and instructor-centered approach without any students' activities in active learning environment. The data analysis is based on student worksheet answers and evaluation survey data collected in a section that lasted 90 minutes. In-class students' activities were supported by two experiments; first one as experimental setting consisted of a glass-water-paper cover and other using a plastic bottle with water. The students showed several misconceptions regarding to the role of atmospheric and hydrostatic pressure, as well as with pressure force acting. The students' difficulties were found in the 5E explanation phase because of lack of students' correct scientific explanations because they have never been taught to gain such abilities. The use of the experiments has been very well accepted by students in view of better understanding of some learning subject matter if is possible to see something real and by doing. 98% pf study participants found that they explored a new and very helpful variety of physics learning supported by experiments and instructor's role to guide them to learn how to explain scientifically the phenomena associated with atmospheric pressure. All students have considered that they should be more active learners who do experiments and learn how to explain physics around them by scientific arguments. These research results show that university physics education should be implemented much more in student-centered instead in instructor-centered learning to increase student learning efficiency.

9. Student difficulties with electromagnetic induction and analysis of a research instrument

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We presented the results of the interviews with nine Croatian high school students concerning their reasoning about electromagnetism (magnetic fields, Lorentz's force, electromagnetic induction, Lenz's law) at the first SEEMPE meeting. This time we will show preliminary results of the second part of the same investigation. Using the results of the interviews, we designed a questionnaire and administered it to 537 high school students in Croatia (aged 16-17) after they had learned about electromagnetic induction in their physics class. The questionnaire consisted of 15 multiple-choice questions and 7 open-ended questions. In the first step of the analysis, we used Rasch modelling to analyse the functioning of the multiple-choice part of the questionnaire. Our analysis shows that the questionnaire is well centred on students' abilities. Item reliability indicates well defined difficulties of test items. However, person reliability warns us about some inconsistencies in the questionnaire. We plan to discuss the functioning of the multiple choice part of the research instrument to verify whether this questionnaire was an appropriate tool for determining students' difficulties with electromagnetic induction. We will also discuss student difficulties with electromagnetic induction that were identified using the questionnaire and compare them with the difficulties identified through preliminary interviews.

10. The inquiry skills required for everyday phenomenon investigation

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There are many different phenomena that students come across every day. Depending on their interest, previous knowledge, they may observe them in detail or may not. There are a lot of phenomenon that everybody has already seen and watched. Mostly common but rather complex phenomenon that involves a set of processes can be used as a good opportunity to develop skills to observe, formulate a problem, develop a hypothesis and plan investigations and hence can be built up to an inquiry activity to be carried out by students. What is the power of candle, we selected as an exemplary problem. Students before starting investigation can begin with observation of the phenomenon and formulating problems connected with candle burning. Raising questions can be supported by teacher-student dialogue when teacher help students to ask additional, more sophisticated questions. Based on students´ formulated questions there can be the investigation plan designed. Taking into account the time limitation and the current state curriculum in physics and availability of tools needed for experimentation we have developed three school inquiry activities. Computer based measurements are carry out by the help of VinciLab and Coach6 software, thermocouple and digital balance. Finally, for the different candle materials heat of combustion is measured.

11. Is the equivalence principle to be included in physics instruction for non-physicists?

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Problems in the physics instruction are often connected with the lack of interest among students and the feeling that the school-acquired knowledge of physics is boring and uninteresting. New methods, among other approaches, try to introduce active teaching/learning (e.g. in the form of inquiry-based instruction) which makes the instruction more interesting and, at the same time, enable students to be better primed for coping with new problems and to get used to think and make hypotheses and conclusions about their observations.

On the other hand, a good way to motivate students seems to be the inclusion of topics which have the potential to stir curiosity, stimulate "sense-making" about the acquired knowledge, to discover new connections among different phenomena and quantities, and to link/relate/bring together various seemingly disconnected pieces of knowledge that they have learnt previously.

In the contribution, we describe the experience of including the equivalence principle as a kind of distraction/"entertainment" into the university introductory physics course for non-physicists. The principle of equivalence was presented to students and they were invited to think, in the form of class activities, about some of its consequences. In particular, the free-floating (inertial) systems were considered and the state of "weightlessness" revisited; the local character of the free-floating frames and the tidal effects were investigated. Students were confronted with some of the unexpected consequences: deflection of light in the gravitational field, red shift, the flow of time in a gravitational field, and the question of the (non-)radiation of an electron in a gravitational field. Some aspects of the quantum mechanical equivalence principle were shown.

The response of students to the "equivalence interlude" was tested through a questionnaire and conversations.

12. Building stronger student knowledge – the case of graphs

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Building deeper and more robust student knowledge in physics is one of the main goals of physics education on all levels. A large-scale study on university students' graph interpretation strategies and difficulties in physics (kinematics), mathematics and other contexts conducted in Croatia revealed many weaknesses in student knowledge and reasoning about graphs. In the study, eight sets of parallel mathematics, physics and other context questions about graphs, which were developed by the authors, were administered to 385 first-year students at the Faculty of Science, University of Zagreb. Students were required to provide explanations and/or mathematical procedures with their answers. Students' main strategies and difficulties identified through the analysis of those explanations and procedures will be described and discussed. Student strategies of graph interpretation were found to be largely context dependent and domain specific. Only a small fraction of students have used the same strategy in all three domains (mathematics, physics and other contexts) on most sets of parallel questions. Students also displayed many reasoning difficulties which were not equally frequent in different domains. The study revealed that students' knowledge about graphs is rather compartmentalized, and suggests that building stronger student knowledge requires building stronger links between different domains. The use of other context problems in physics and mathematics teaching may be a step in that direction, since they seem to have a potential to expose and develop student reasoning more than the standard, domain - specific mathematics and physics questions. This one and other implications for teaching about graphs will be discussed.

13. Framework for using modern devices in an introductory physics course

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Introductory physics courses are typically employing experiments that originate from 16th to 19th century and rarely from 20th or 21st century. On the other hand, our students are every day surrounded by many devices and materials that are the result of scientific and technological achievements of the last decades. In this talk we will present a framework for analyzing possibilities for using modern devices in an introductory physics course. We will discuss how the framework can be used to introduce into physics curriculum such complex physics systems as light emitting diodes (LEDs).

14. Results of a delayed transfer test of students' understanding of buoyant force and related phenomena stemming from two different learning experiences

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This contribution describes delayed transfer test aimed at determining the degree of long-term adoption of the conceptual understanding of buoyancy and related phenomena. The transfer of knowledge, a process of activating previously learned skills and concepts and applying them to novel situations, is very important, not only for real-world application of knowledge, but also as a foundation for learning and understanding of new topics.

The test was conducted 3 months after the learning sequence, as a part of the first author's research doctoral project "Changes in students' alternative conceptions during physics learning - Effects of traditional teaching and active learning methods". The research was conducted with a sample of 153 seventh-grade elementary school students (13 years old) in Uzice (Serbia) as a pedagogical experiment with two parallel natural groups. The control group had traditional lectures, characterized by teacher's verbal presentation of knowledge and passive role of students. At the same time, teaching and learning in the experimental group were implemented through those methods that require the use of more complex mental processes, creativity and ability to apply knowledge in different situations, freedom of choice and expression, as well as peer-to-peer collaboration.

The delayed transfer test consists of five questions with varying degree of complexity, designed to test students' knowledge on buoyant force, conditions leading to floating and sinking, as well as the presence of certain alternative conceptions on these phenomena.

The contribution reports students' achievements on delayed transfer test as functions of teaching and learning methods they were exposed to (traditional vs. active learning), their cognitive development and general achievement levels. The results clearly point out the need for application of active learning methods with the goal of obtaining longer-lasting knowledge on buoyancy and related phenomena, and overcoming alternative conceptions on floating and sinking.

15. Analysis of children's sketches

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The quickest way to find out what children already know about some natural phenomenon is to let them make sketches. Giving children such a task, one has to be careful to give appropriate instructions of how to do sketches: the instructions should not be too long, but nevertheless precise enough so that children know what to draw and in what way. Then the children's sketches have to be analyzed—this is the only way to find out which concepts have not yet been mastered by children, what experiments are still to be performed (or which phenomena are to be observed once again and what has to be repeated in order that a topic is mastered by the pupils).

The students of Primary Teacher Program wanted to perform, within their seminar work, a more detailed analysis of the pupils' sketches. In the course of the field work in one of the primary schools, a questionnaire was administered among pupils of the second grade (26 children), of the fourth grade (32 children) and of the fifth grade year (58 children). The pupils sketched themselves and their shadow in the morning, in the afternoon and at noon. Their sketches were handed over to the students in order to be analyzed. We found out that the students had a lot of problems in doing the analysis. We therefore decided to dedicate more time to this activity. We discussed with students how to prepare the questionnaire, how to prepare the analysis, we discussed the analysis itself and the problems encountered by both the pupils and the students.

16. Exploration of students' ideas on superconductivity

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Superconductivity is an important context to be integrated in secondary school currcula because it is a significant part of the physics of the '900, has important applications (Aubrecht 1989; Gil, Solbes 1993; Hake 2000), can be addressed at different levels (Osterman et al 1998, 2000; Guarner 1992). An educational approach to superconductivity was designed, based on the exploration of the electrical conducting properties and the magnetic properties of superconductors (Viola et al. 2008; Michelini, Santi, Stefanel 2014). Research experimentations, carried out in Italian High Schools was performed, in 10 hours of inquiry based activities, conducted using Stimuli Worksheets and a pre-post test (Stefanel, Michelini, Santi 2014; Michelini, Stefanel, Vanacore 2014). The results of the experimentations evidenced that the ways in which students give account the phenomenon of levitation of a magnet on a superconductor are related to how they describe, by the field lines and the magnetization vectors, the magnetic fields in the material and magnetic interactions in general.

References

Aubrecht G. (1989) Redesigning courses for the 21stcentury. AJP, 57, p. 352-359.

Gil D. P., Solbes. J. (19939 The introduction of modern physics. IJSE, 15, p.255-260.

Guarner E., Sánchez A.M. (1992) The SC bird. The Phys. Teach.,30, p. 176-179.

Hake R.R. (2000) Is it Finally Time to Implement Curriculums? AAPT Announcer 30(4) p. 103.

Michelini M, Santi L, Stefanel A (2014) Basic concept of superconductivity, in FFFP12, Burra G. S., Michelini M, Santi L, eds, Springer, NY, Dordrecht, London, pp. 453-46

Michelini M., Stefanel A., Vanacore A. (2014) Exploration of students' ideas about superconductivity, in Active learning – in a changing world of new technologies, Leoš Dvořák L. and Věra Koudelková V., eds, Charles Univ. Prague, pp. 541-551

Ostermann F., Ferreira L.M., Cavalcanti C.J.H. (1998) Tópicos de física contemporânea no ensino médio. Revista Brasileira de Ensino de Física, 20, p. 270-288.

Ostermann F., Moreira M.A. (2000) Física Contemporânea em la escuela secundaria. Revista de Enseñanza de las Ciencias, 3 (2), 18. p. 391-404.

Stefanel A, Michelini M, Santi L (2014) High school students analyzing the phenomenology of superconductivity, in Tasar F.ed., WCPE 2012, Pegem Akademiel, pp..1253-1266.

Viola R., Michelini M., Santi L., Corni F. (2008) The secondary school experimentation of SC, In Frontiers of Phys. Educ.. Ed. R. J-Sepic et al., p.190-196. Girep-Epec, Zlatni. Rijeka

17. Student understanding of physical measurement

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Physics is an experimental science and measurements are central to evaluation and formulation of ideas about the physical world. Assessing the reliability and validity of the measurements is essential part of measurement. However, physics education researchers have identified a number of student difficulties in understanding measurements and related uncertainty. Previous research has indicated that the graphical representations of data might help students in data processing and data comparison but this was not systematically explored. In this study, a paper and pencil test consisting of eight questions and six corresponding explanations was administered to 48 first year students without laboratory experience and 53 senior years students at University of Zagreb who were all prospective physics teachers. In half of the tests, graphical representation of data was also provided. In addition, eye movements of 30 senior years students were recorded while they were solving the same test. Overall, many students were unable to appropriately use the idea of measurement uncertainty. They exhibited the most difficulties while solving the test item that involved recognition of an outlier and its exclusion in calculation of the mean value. Comparison of measurement results was also very difficult for many students. In contrast to these items, most students were able to write down the results of measurements including measurement uncertainty with the correct number of significant figures. As it was expected, older students generally performed better than first year students indicating that laboratory experience had a positive effect on student understanding of measurement uncertainty. Furthermore, graphical representation of measurement data helped students to perform better on test. Eye tracking data confirmed this finding and provided further insight into student strategies in data processing.

18. University Students on Incompatibility of Observables in Quantum Mechanics

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Conceptual change from a classical to a quantum perspective is a challenging task for university physics students. The interpretation of the physical behavior of micro-systems requires the adoption of new basic concepts such as incompatibility of observables, whose construction is non-intuitive, and implies the re-definition of familiar notions such as the state of a system. In turn, the structure of these new features is encoded in a highly mathematical formalism, which requires as well making physical meaning of new entities (e.g. the operator structure of observables) and the re-interpretation of familiar ones. Research evidences that students have difficulty both with concepts and with the use of formalism in qualitative tasks, but incompatibility in its many facets received little attention in literature. We administered a 15-item questionnaire focused on this topic and related formal structures to 40 physics students of three Italian universities. Semi-structured interviews were scheduled on a subset of students. Results concerning translation processes between math and physical meaning show that most students only look at the square modulus in order to reason on physical information encoded in quantum state, thus neglecting phase relations and their connection with incompatibility.

WORKSHOPS

1. Simple experiments for enhancement of pupils' curiosity about science

Dagmara Sokolowska, Daniel Dziob, Justyna Nowak, Aleksandra Wańczyk, Mateusz Wojtaszek, Witold Zawadzki, Grzegorz Brzezinka

2. Hands-on experiments with hydrogels

Jerneja Pavlin

1. Simple experiments for enhancement of pupils' curiosity about science

Dagmara Sokolowska[1,2], Daniel Dziob[1], Justyna Nowak[1], Aleksandra Wańczyk[1], Mateusz Wojtaszek[1,2], Witold Zawadzki[1,2], Grzegorz Brzezinka[1,2]

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The research results show that positive attitude towards mathematics, science and technology school subjects decreases with age and recently it has been indicated that the biggest drop takes place between ages 8 and 11 (Sokolowska et al., 2014). At the same time the evidences have been collected to conclude that more effort is needed at early stages of schooling for implementation of group work, more practical activities and tasks enhancing the analytical thinking (e.g. de Meyere et al., 2014). On the other hand our experience from a bunch of open events, reveals an enormous increase of children's interest in all kinds of popular science for the last few years.

This strong children's motivation towards experimentation and interest in scientific knowledge gathered from different resources encouraged us eight years ago to start a new national competition in science for primary school (Sokolowska, 2009). The idea was to engage children aged 6-13, together with their parents and/or teachers in guided science hands-on and minds-on activities at school or at home. The key role in the competition is played by simple experiments, based on everyday materials. The experimental part is then followed by a multiple-choice test, examining their mathematical and scientific thinking and knowledge.

This workshop is organized to engage the participants in a collection of simple experiments we have designed for six grades of primary school for the last seven runs of the contest. The idea of the workshop is to share good examples of hands-on simple activities and to exchange similar experience among the audience.

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References:

de Meyere, J., Sokolowska, D., Folmer, E., Rovsek, B. and Peeters, W. (2014). MST curricula for 5, 8, 11 and 13 year olds researched by SECURE project across the Europe. Proceedings of the Irish Association for Social, Scientific and Enviromental Education, Annual Conference 2013, Dublin 20-21 June 2013, pp.89-106. Retrieved from: http://www.tara.tcd.ie/bitstream/handle/2262/69112/IASSEE%20Final%20Report-2.pdf?sequence=1

Sokolowska, D. (2009). Firefly – a new contest in science for primary school, Proceedings of

GIREP-EPEC & PHEC 2009 International Conference, August 17-21, Leicester, UK, pp. 352-357. Retrieved from: http://physics.le.ac.uk/girep2009/ConferenceProceedings/GIREP2009_ConferenceProceedings_Volume1.pdf

Sokolowska D., de Meyere J., van Graf M., Rovsek B., and Peeters W. (2014). Intended, implemented and attained curricula across Europe: what can research tell us?, Proceedings of the ESERA 2013 Conference, Strand 10. Science curriculum and educational policy, pp. 150-161. Retrieved from: http://www.esera.org/media/eBook_2013/strand%2010/Dagmara_Sokolowska_07Feb2014a.pdf

2. Hands-on experiments with hydrogels

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Hydrogels are superabsorbent polymers which are topic of ongoing researches of modern materials. They are used in agriculture, construction and horticulture industry as well as in medicine. Hydrogels are also interesting from the educational point of view since they present the novel smart materials with special properties. Especially hydrogels in spherical shape are very useful for school experiments. Students can study time dependence of the volume of hydrogels and observe the swelling under the USB microscope (Figure 1), play with their size and determine densities, explore that all transparent object cannot be seen in the transparent liquids, experience that materials can change the properties of light (Figure 2), measure and record the size of the image seen under the hydrogel sphere, study the influence of media's properties on swelling, etc. All these experiments, showing hydrogels' special properties and some physics concepts, will be presented during the workshop. You will experience that presented experiments can give ideas for more hands-on activities, so there will be also time to try some of them.

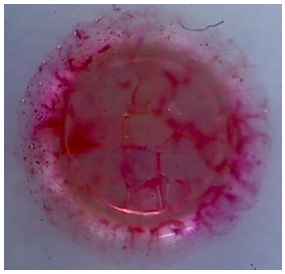

Figure 1. Hydrogel in spherical shape immersed in water and observed under the USB microscope.

Figure 2. Directing the green laser beam to the spherical hydrogel in coloured water.

POSTER CONTRIBUTIONS

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10. 'Tea with MrBernoulii', in other words Physics in Inquiry-Based Science Education (IBSE)

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1. The pedagogical treatments of weight and weightlessness in physics textbooks for primary school in Bosnia and Herzegovina: An analysis of coherence between curriculum elements and textbook contents

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Since the first human cosmic flights, more than 50 years ago, unusual physical phenomena related to "weightlessness" called for a revision of the concept of weight. It was vividly discussed in pedagogical literature and two main conceptual approaches were proposed and used in physics textbooks.

In one approach, the weight of a body is equal to the gravitational force of the Earth (or other planet) acting on it. A body inside a satellite behaves as "apparently weightless" because the Earth still attracts it gravitationally. A body would be "truly weightless" would happen in the absence of any gravitational force acting on it. In the other approach, the weight of body is equal the force the body executes on a spring scale. Inside a satellite, a body is "truly weightless" because it is unable to execute a force on a spring scale due to the fact that both are in free fall toward the Earth.

In all analyzed physics textbooks for primary school, published recently in Bosnia and Herzegovina, the Earth´s gravitational force on a body and its weight are conceptually distinguished. The second is defined as a pressing force a body executes on the horizontal supporting surface or stretching force it executes on a spring it is hanged on.

Regarding the coherence between physics curriculum for the eight grade and the contents of the corresponding textbooks, we report two facts. In the Serb Republic (Republika Srska), state of weightlessness is defined in the curriculum as the state in which gravitational forces are totally absent. Surprisingly, the author of singular analyzed textbook does not mention that type of weightlessness and exposes only free-fall weightlessness.

In the case of the other political part of Bosnia and Herzegovina (Federacija Bosna i Hercegovina), authors don't respect the curriculum suggestion that students should "describe and explain the state of weightlessness". The treatments of weightlessness are mainly verbal, superficial and, in some cases, conceptually misleading or explicitly wrong (astronauts in space are weightless because there is no gravitational force).

It seems that the conceptual treatments of weight and weightlessness in physics textbooks in Bosnia and Herzegovina follow Soviet pedagogical tradition, a phenomenon that was recently analyzed for the case of physics textbooks in Croatia.

2. Physics and art in education: The two project ideas from Bosanska Krupa High School

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High school students from Bosanska Krupa, a small town in Bosnia and Herzegovina, were able to make a connection between physics and art. In this paper are presented the two project ideas, „Physics on photograph", and "The Nailpolish Art" along with many other activities that helped students in various ways to be more interested in learning physics as active learners. As they went on photographing everyday occurrences in nature, they discovered laws of optics and as such, learned the basic concepts in that field of science. During this project the talented students were taking the pictures with simple cameras and showed their logical observation of things around them. As a proof of their excellent job is a picture that „The Physics Teacher“ has published it in its volume 52(5), 2014. This incredible shot shows the waterfall freezing from outside with an enormous ice pillar formed from the cascading waterfall during an exceptionally cold Bosnian winter time. In the second project the students were introduced to learn about water surface phenomena and the risks that nailpolish can pose to the human health. They have also learned to view science as art, and art as science through the accidental painting of a famous painter Jackson Pollock. These implemented projects according to the basic idea to connect physics as an exact science and art as a different human discipline show that the two fields should be included in the high school physics' curriculum. It means that high school students can be oriented into human disciplines and social work fields to promote physics as more attractive science to be learned by young people. They could discover places and events around them of parallel significance for both physics and art.

3. Respiratory system - at the crossroads of physics and biology

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In many educational systems the science disciplines, like physics, chemistry and biology, are taught as one interdisciplinary subject, called science, integrated science or world orientation. The main purposes of such approach are to show the relationships between different science disciplines, and to promote the idea of science integrity and complementarity.

The main objective of this work was to demonstrate the possibility of taking advantage of the interdisciplinary character of biophysics for teaching science at various levels of education. To this end, we have designed a learning unit, based on some experiments, which enables modelling of the selected vital functions and learning of some concepts, associated with the respiratory system. The underlying themes and the difficulty levels of the tasks were adjusted so as to suit a variety of age groups, ranging from preschool to higher education.

The proposed learning unit is divided into three main sections to be utilized in a sequence. In the first section students are familiarized with the expansion and contraction of lungs and the role of midriff. They are asked to prepare their own model of lungs and to play with it in order to be able to fill in the tasks in a worksheet. This part can be implemented at each educational stage. The second section focuses on the lung volume and experimental determination of the maximum vital capacity of lungs [1]. In the course of the activities students are asked to find out the capacity of their own lungs. Due to the necessity of mathematical calculations, this part can be useful for teaching science or physics in higher grades. Last section is linked to the maximum expiratory pressure and to the calculation of this quantity done by utilizing the ideal gas law [2].

All experiments can be conducted with common, everyday objects, so the learners do not need any special equipment. The theoretical and mathematical background is provided in the worksheets, which contain also instructions for performing experiments. Hit her to respiratory system experiments were conducted on lessons in schools and during the events popularizing science, e.g. Researchers' Night.

Acknowledgment
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References

[1] http://humanphysiology.hubpages.com/hub/Lung-Volumes-and-Capacities
[2] S. Wilson et al, Predicted normal values for maximal respiratory pressures in Caucasian adults and children, Thorax 1984; 39: p. 535-538

4. An initial study of the transfer of knowledge through two-stage predict-observe-explain sequence: the case of floating bodies with fixed and changable volume

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One of the key objectives of physics education is that students are able to apply the physics knowledge in situations that are different from those in which the knowledge was gained. We present the results of an initial study in which we investigated the transfer of knowledge through the use of predict-observe-explain method in the case of the floating behaviour of two similar systems: an inflated balloon with changeable volume and a glass sphere with fixed volume. The balloon is connected with a metal weight, making possible that it floats in the water, touching the water surface from below. The glass sphere floats the same way.

One group of high-school students (N = 50) had the task to predict what will happen to the balloon when pushed down a bit by a glass rod. Then they watch a short video clip that shows what actually happens and finally explain the observed events. The entire process is then repeated, asking students to predict and describe the behaviour of the glass sphere after being pushed down. Another group of students (N=50) did the same, only the predict-observe-explain method was first used for the case of glass sphere, and then for the case of the balloon.

Comparison of the performances of the two groups shows the effect of treatment order of similar systems on the predictions and the search for the causes of their different behaviour. From the students' responses, we conclude that there are two type of students transfer performances. In the first, more frequent type, students make a superficial transfer of knowledge from the first to the second situation because of their apparent similarities. That cognitive behaviour might be called a »fast generalization«. In the second, less frequent type of the knowledge transfer, the students make deeper physical analysis, that includes taking into account the specificity of the described system.

5. Student`s findings at solving young physicist tournament`s challenge - Thick lens

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The Young Physicists Tournament is upper secondary school student`s competition in solving physical problems that leads talented students to independent and creative scientific activity. Students solve open-ended problems not only theoretically, but also experimentally. It broadens not only their knowledge but also a series of scientific skills, like formulate the problem, making predictions, plan own investigation, collecting data, making conclusions, present and argue own results. In the contribution there is presented an exemplary solution one of selected challenge from year 2015 - Thick lens. The activity is considered as bounded inquiry. The problem assignment is stated: “A bottle filled with a liquid can work as a lens. Can one use such a lens to scorch a surface?” By mentoring the team of high school students we investigate and explain the principles of thick lens and influencing of appropriate parameters such as thickness, shape, colour and final temperature at the focus point.

6. Students' misconceptions of heat and temperature concepts

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Studies focusing on teaching of science concepts show that students are unable to learn the scientific meaning of the target concepts while they are constructing newly acquired knowledge with their prior experiences during or after teaching and as a result misconceptions emerge. In this paper we used the concept test Introductory Thermal Concept Evaluation, developed by Shelley Yeo and Marjan Zadnik of Curtin University in Western Australia. Solving test was approached by 42 students from the University of Tuzla (Faculty of Science, Department of Physics) and 100 third-grade JU Gimnazija Živinice. The research results show that the understanding of the fundamental concepts of heat and temperature generally low. As for the questions which have proven more difficult, they are most often been problematic for both groups of which can be seen as well as students have conceptual problems, but students generally and on each of these tasks are achieved better success. To make the students gain experience in understanding concepts, conceptual change approach provides a set of guidelines to help students that provide special learning environment, such as identifying common misconceptions about heat and temperature, activating students' misconceptions by presenting simple qualitative examples, presenting descriptive evidence in class that the typical misconceptions are incorrect, providing a scientifically correct explanation of the situation, and giving students the opportunity to practise the correct explanation by using questions. Teachers must become more involved in developing and designing the optimum conceptual change instruction and teachers must be informed about the usage and importance of conceptual change conditions, and they must plan the instructional activities according to it.

7. Firefly – not only a contest in science

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Firefly (Swietlik) is a self-financing competition which is organized in Poland since 2007 by the Academy of Young Explorers Fundation. This activity is addressed to children aged between 7 and 13 and is available for all pupils across country. The main goal of Firefly is to show how interesting and fascinating the exact and natural sciences are.

The contest is organized as a multiple choice test, taking place at the same time in the end of March in all participating schools. A separate test is prepared for each school level. Questions are equally composed of three categories: (1) biology, chemistry and medicine, (2) ecology, geography and climate, (3) engineering, physics and astronomy. Before the test the pupils are encouraged to perform a set of simple hands-on experiments selected for the competition each year. Children do them at school during classes or individually at home at any convenient time before the test.

In first edition of Firefly a number of 4664 pupils from 245 schools took part in the contest. After seven years the number raised to 29 000 pupils from 715 schools.

In our presentation we will show the results from several runs, including analysis of the data derived from some multiple-choice tasks on physics and the conclusions drawn on their basis.

Acknowledgment
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8. High school students' knowledge and understanding of the phenomena associated with atmospheric pressure

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This research study was conducted in the spring of 2012, and it was attended by first-year (N=60) and third-year (N=34) students of prestigious high school in Canton Sarajevo, Bosnia and Herzegovina. The purpose of this study was to explore students' knowledge and understanding of the phenomena associated with atmospheric pressure. Also, this study investigated students' misconceptions, and whether there has been any positive change in students' understanding. Questionnaire of eight questions, that was used as a pretest and posttest, was created by researchers to collect data for quantitative-qualitative analysis. Between pretest and posttest students attended several active learning sessions, contained of several in-class experiments and discussions. Students showed inferior results than expected. Misconceptions and misunderstandings of the phenomena associated with atmospheric pressure were confirmed. Students were not good in providing explanations, and scientifically based arguments were almost never used. On the other hand, the students expressed positive attitude towards active learning. They noted that active learning should be used in teaching more often. Classes would be more interesting and processed contents would be more understandable and easier to learn. Results of this research should encourage physics teachers to introduce changes to the traditional way of teaching, to adapt their teaching to the needs of society and to enable students to actively participate in the teaching process.

9. How to observe electric current and resistance?

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The electricity is known as a topic that is described as an abstract and difficult to visualize. The concepts such as electrical current, electrical circuits, electrical resistance, voltage and others are commonly discussed and explained with the help of hydraulic analogy (canal system, water mills, pumps, etc.). The above analogies helps to better understanding of the electricity, but only if the students understand it.

The resistivity is a concept that is most commonly introduced through the Ohm's law. The resistor(s) is/are connected in electric circuit, where the current and voltage are measured. Although the resistors are one of the most basic electronic components and have a convenient linear dependence of the current on the voltage, the resistors are still abstract or "black-box" elements. Students are not able to observe its properties directly. With ambition to bring the concept of resistance closer to students an alternative or supplementary device for visualization of the effects of resistance is presented in this contribution. The electronic device is used as a detector of the resistance, where the frequency of the blinking diodes gives us the information of the electrical current. With this device the resistance becomes "visually observable quantity".

The activities connected to resistance were designed on the basis of active learning strategy, where we try to encourage students to develop ideas, interdisciplinary integration of knowledge, technical skills training, teamwork and discovering the basic principles of researching. The role of a teacher using active learning teaching strategy is particularly challenging. A teacher is expected to guide students and provide the tips and information for their work. The building and use of the device allows creativity and innovation for both: teachers and students.

With ambition to use active learning activities starting in elementary school we will stress out ideas for activities that can be done with the electronic device which perfectly serves for wide resistance interval.

10. 'Tea with MrBernoulii', in other words Physics in Inquiry-Based Science Education (IBSE)

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Inquiry-Based Physics Learning is a didactic method which makes students become researchers – they are encouraged to ask questions, hypothesize, plan investigation, conduct experiments, draw the conclusions on their own, explore and find the answers to the research questions. Such a method is particularly effective for engaging and motivating students, including those who do not really like physics.

We have organized the inquiry-based physics workshops on pressure and the principles of Bernoulli's law. Target group consisted of (1) the first- and second-year students studying subjects other than exact or natural sciences and (2) lower secondary school learners undergoing reclamation due to the problems with the law violation. During an one-hour workshop the entire cycle of IBSE has been implemented. At the end of the session the group used their new knowledge to solve a new task, namely to prepare the tea utilizing the Bernoulli's law.

The activity was particularly successful with engagement of lower secondary learners who started the workshop with deep reservation and finished it with elevated self-confidence and being enthusiastic about physics.

Acknowledgment

This work is supported by the Akademickie Centrum Kreatywności research project funded by the Polish Ministry of Science and Higher Education within Innovative Economy Programme, action POIG.01.01.03-00-001/08,which received funding from the European Union under European Structural Funds.

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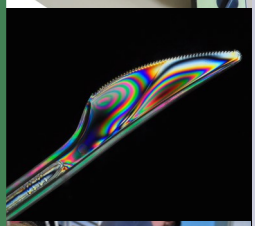

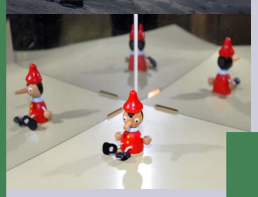

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