GIREP SEMINAR 2016
August 30 – September 3, 2016
Kraków, Poland

50th Anniversary GIREP

Research-based proposals
for improving physics teaching and learning
– focus on laboratory work

Organized by:
International Research Group on Physics Teaching (GIREP)
Faculty of Physics, Astronomy and Applied Computer Science
of the Jagiellonian University in Kraków

Editor
Dagmara Sokolowska

Editorial Secretariat
Anna Gagatek
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Minister of Science and Higher Education

We would like to acknowledge the financial support from KNOW grant no. 62/KONF/DS/2016.
Preface

The Proceedings present selected contributions from the international conference GIREP Seminar 2016, organized by GIREP vzw organization and the Faculty of Physics, Astronomy and Applied Computer Science at the Jagiellonian University, Kraków, Poland. It was our great privilege to host GIREP members and friends in the year of the 50th Anniversary of GIREP organization. The first day of this event offered an opportunity to recall special memories and to thank everyone that has contributed to the growth of GIREP during the last half-century.

The general seminar topic Research-based proposals for improving physics teaching and learning – focus on laboratory work emphasized the importance of laboratory activities in physics education. The overall aim of this seminar was to highlight the various aspects of laboratory work involved in establishing an environment where physics teaching and learning can take place, and in particular the development of physics literacy. Several topics have been discussed in order to line out a wider view of laboratory work at all levels of physics and science education, from primary school to physics courses at the university.

The format of this seminar was proposed in the style of the old-time GIREP meetings – with keynotes, oral presentations and poster presentations focused on six themes, followed by in-depth discussions in small groups of researchers and practitioners in sessions led by leaders of six Working Groups (WG). The contributions from six keynote speakers, widely respected in the community of physics education, as well as a comprehensive variety of oral and poster contributions, offered an unforgettable occasion for a fruitful exchange of thoughts and ideas.

The impact of physics education research on the educational design and practice of physics laboratory was the focus of WG1: Experimental Lab in Introductory Physics Courses. Presentations showed studies of students’ learning in the laboratory and difficulties they come across, as well as, teaching proposals for specific topics at secondary schools, colleges and the first years of university. In WG2 two topics were encompassed. Advanced Experimental Laboratories, rarely addressed by instructors and researchers, who are focused more on introductory physics labs, was chosen to fill this gap and open a broader discussion on the role, goals and examples of the advanced laboratories in physics student education during their bachelor and master studies. Modern Physics topics being of the most interest of learners at all ages, appear to be rarely addressed in high school and during the first years of physics studies due to time limitations and the lack of teachers’ competences. Contributors taking part in discussion tried to answer the question how to translate complex theories and highly-advanced experiments into language understandable and appreciated by less advanced students.

Since a modern laboratory can barely be operated without ICT, thus the design, evaluation and characterization of resources and environments for physics teaching and learning with use of ICT was addressed in WG3: Lab Work and Multimedia. Participants focused in particular on online learning environments, simulation and modeling tools, virtual laboratories and open sources. Self-regulation, reflection and collaboration in digital learning environments in context of lab work were discussed. WG4 Conceptual Lab and Mathematization addressed theories, models, and empirical results on conceptual understanding, conceptual change and development of competences in context of laboratory work, as well as methodology for investigating students’ processes of concept formation and concept use on the basis of experiments and strategies to promote conceptual development throughout laboratory activities. A broad meaning of the term mathematics that includes all kinds of structuring and
ordering physical processes: using abstract methods like idealization and modeling, as well as using a broad range of mathematical elements such as diagrams, graphs and formalized sketches (e. g. arrows) and equations was discussed in the context of physics laboratories.

A specific role and character of laboratory activities encourage the teachers to search for non-standard assessment strategies. In lab more than in other physics learning environments the formative assessment for development of research skills and conceptual understanding plays a dominant role. A detailed discussion on that topic was the core of WG5: Assessment for learning through experimentation.

In order to attract more students, attention for science should be brought naturally, with use of everyday materials and in everyday context. Understanding of physics and appreciation of its beauty starts when observing usual but at the same time – amazing phenomena around. Traditional laboratory environment is extended nowadays beyond the lab space. Experiments are shown and tried out during numerous shows, festivals and other experiences outside the classroom, including those organized by institutions other than schools. Simple experiments should serve as the ignition of ideas, concepts and the notion for development of intuition in physics, not only at early ages, but across entire education. There aspects of learning, additional to traditional education, were the point of discussion in WG6: Low Cost Experiments and Inquiry.

The seminar was attended by 115 participants representing 28 countries. The scientific seminar program offered altogether 6 invited talks, 63 oral and 42 poster presentations. After the seminar 54 papers were received on all seminar topics. The articles went through a rigorous process of in a double-blinded peer-review, involving members of the Editorial Board and twelve additional referees in order to guarantee the quality of the content of this contribution. As the result two publications are issued, the book Focusing on Lab to improve Physics Teaching and Learning. Research Based Proposals, published by Springer and GIREP Seminar 2016 Proceedings book, presented here.

The organization of the seminar would not have been possible without help and co-operation of many people. First of all, we would like to thank Prof. Marisa Michelini, GIREP President, for her constant help and support. We sincerely thank the members of the Advisory Board and colleagues on the Local Organizing Committee for their dedication and commitment to this event. We are also deeply thankful to all reviewers, Working Group Leaders and the Head of all Leaders, Dr. Ian Lawrence. We would like to express our gratitude to six invited speakers for their valuable presentations that served as the foundation for the group discussions throughout the entire seminar. We are also deeply indebted to Prof. Paul Black who joined the anniversary day of GIREP with his special talk on-line and to Dr. Seta Oblak and Dr. Zofia Golab-Meyer for their contribution to the seminar on the history of GIREP and its impact on physics education research and development.

We would also like to thank all the participants of the GIREP Seminar 2016, for submitting proposals, advance preparations for discussions and sharing their ideas with the GIREP community. We hope that these Proceedings will give the reader an opportunity for deeper comprehension of the Laboratory Work aspects to improve physics teaching and learning.

Kraków, Poland

Dagmara Sokołowska