

## Physics Education PhD Program at Eötvös University, Budapest

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We briefly summarize the main features of the Budapest PhD program in Physics Education, initiated three years ago.

### Introduction

As a possible measure against the continuous decrease of interest in physics among high school pupils, our Graduate School in Physics decided to launch a program in Physics Education in 2007. Earlier, teachers had the possibility to earn a PhD degree in Physics by carrying out scientific research only, or in theoretical pedagogy, where physics plays a minor role. The new program formulates that establishing a novel, inspiring way of teaching modern or classical aspects of physics in a class is an achievement equivalent to traditional research results. The program is open for active high school teachers, or for BSc lecturers without a degree.

### Research in Physics Education

The candidates carry out their research at their own school. At the moment, they cannot receive governmental scholarship, but their tuition fee is reduced in view of the external research location. Such a PhD opportunity was opened within Hungary (in Debrecen and Szeged) a few years earlier. The Budapest Program is special since it offers an education tailored specifically for our teacher-students.

The students can either choose the research topics from a publicly available list, or they can come up with their own suggestions. In most of the cases these can be accepted (after minor corrections), and an appropriate advisor is chosen. We mention here a few interesting research topics: 'Non-conventional modern physics in the classroom', 'Dimensional analysis and models', 'Environmental physics in the high-school', 'Interactive e-learning materials for BSc-level', 'Enhancement of the activity of pupils with interest in humanities', 'Teaching physics outdoors'.

The research work is initiated right after entering the PhD school, but the first two years are devoted mainly to a regular attendance of lectures. For technical reasons they are held on an agreed Saturday of each month, as the teachers cannot count with extra holidays just because of their PhD studies (they are happy if the school is ready to share the tuition fee). In order to have a broad view on physics, sixteen courses should be attended, implying on average four 1.5-hours lectures on these Saturdays. The language of the lectures is Hungarian. They are substantiated by a thorough literature and/or material accessible via Internet.

## Courses

The main course, bridging through all four semesters, is 'Physics teaching I-IV'. This not only treats all important aspects of the high school curriculum, but also covers non-conventional topics like scientific communication, popular journalism, and the problem of pseudo-sciences. Attention is paid to talent spotting, and to the discussion of the problems of local and international physics competitions, including those of the International Physics Olympiads. A course summarizing the basic theoretical ideas in the history of physics makes the picture more complete.

Special emphasis is put on demonstration experiments. The course 'Groundbreaking experiments of physics' presents all great experiments of the history which can be realized with standard university (and perhaps high school) equipments. Another course is devoted to the use of computers in evaluating experimental data, and the use of Internet in teaching.

'Everyday physics' is also supported by a number of experiments. We offer a course and practice in e-learning. Interestingly, the selected research topics of the first years fall mainly under two categories: environmental physics and the physics of complex systems. This interest is aimed to be satisfied by courses on environmental flows, on global problems of energetics, and on cooperative phenomena, as well as on chaos and dynamical systems.

The courses on relativity and on the properties of elementary particles renew and extend the candidate's knowledge of these chapters of modern physics. The effort of presenting interdisciplinary aspects lead to the introduction of the courses 'New results in astronomy', 'Physics in chemistry' and 'Physics in biology'.

## Other activities

The results of the candidate's research in physics education should be published after the third year of studies. We request at least one publication in a refereed international journal (for instance, Journal of Physics, European Journal of Physics, Physics Teacher, Physik in der Schule). We urge therefore (and support as much as we can) their participation at international conferences. Three other publications are requested in appropriate Hungarian journals. The participation at local physics teacher conferences, like e.g., at the assembly of the Hungarian Physical Society, are also strongly recommended. Last August we organized a 3-day international conference for Hungarian-speaking physics teachers in Budapest, with about 120 participants. The conference proceedings is appearing soon (see <http://fiztan.extra.hu/konferencia/program/szekciok.html>) with a short abstract in English, for most of the papers. Half a day of the program was devoted to different programs in talent spotting, including local and international physics competitions.

The closing exam of the PhD studies should consist of (as for anyone in our PhD School) three topics. The main topic is Physics teaching, the two others can be chosen by the candidates by combining two of the courses at least. The writing of the theses and the defense takes place under the usual circumstances.

## Closing remarks

In the last years we had an overwhelmingly positive reaction from our colleagues in high schools. The average number of new students entering our Physics Education Program is 7-8 persons each year. We welcome (and try to financially support) candidates representing the Hungarian-speaking minorities of the neighbor countries: currently we have two students from Romania and one from Slovakia. The first defenses are expected later this year or early next year.