

THREE STAGES OF THE FUTURE PHYSICS RESEARCHERS TRAINING AT V. N. KARAZIN KhNU – SCPT LABORATORY

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The work is dedicated to the good practice examples in the process of preparation of the future students for the departments of Physics. It has been supposed the three stages of the secondary school students' experimental skills development. To teach students how to make simple research the extracurricular courses have been organised at the V. N. Karazin KhNU — SCPT Laboratory which is situated at the Department of Physics and Technology at the premises of V. N. Karazin Kharkiv National University. During such training students gain special profound knowledge of physics and seriously improve their experimental skills by doing self-made experimental projects using recycled materials, simple household objects, ordinary toys by means of real tools.

Keywords: experiences, interactive methods of teaching, students, physics.

ТРИ ЕТАПА ПОДГОТОВКИ БУДУЩИХ ИССЛЕДОВАТЕЛЕЙ В ОБЛАСТИ ФИЗИКИ В ЛАБОРАТОРИИ ХНУ ИМЕНИ В. Н. КАРАЗИНА — НФТЦ

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Работа посвящена удачному опыту в привлечении и подготовке школьников к поступлению на физические факультеты ВУЗов Украины. Выделяются три этапа развития и формирования экспериментальных умений школьников. Для дополнительного обучения детей сотрудники физико-технического факультета ХНУ имени В. Н. Каразина и НФТЦ создали специальную лабораторию интерактивных методов обучения. Во время занятий учащиеся школ Харькова и области получают дополнительную подготовку по физике, серьезно повышают свои экспериментальные навыки, знакомясь с научным исследовательским оборудованием. Школьники делают свои первые исследовательские проекты, используя предметы домашнего обихода, обыкновенные игрушки, а также отходы производства и ненужные части недорогого оборудования.

Ключевые слова: опыты, интерактивные методы обучения, ученики, физика.

ТРИ ЕТАПИ ПІДГОТОВКИ МАЙБУТНІХ ДОСЛІДНИКІВ У ГАЛУЗІ ФИЗИКИ В ЛАБОРАТОРІЇ ХНУ ІМЕНІ В. Н. КАРАЗИНА — НФТЦ

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Робота присвячена вдалого досвіду в залученні і підготовці школярів до вступу на фізичні факультети ВНЗ України. Виділяються три етапи розвитку та формування експериментальних умінь школярів. Для додаткового навчання дітей співробітники фізико-технічного факультету ХНУ імені В. Н. Каразіна та НФТЦ створили спеціальну лабораторію інтерактивних методів навчання. Під час занять учні шкіл Харкова і області отримують додаткову підготовку з фізики, серйозно підвищують свої експериментальні навички, знайомлячись з науковим дослідницьким обладнанням. Школярі роблять свої перші дослідні проекти, використовуючи предмети домашнього вжитку, звичайні іграшки, а також відходи виробництва і непотрібні частини недорогого обладнання.

Ключові слова: досліди, інтерактивні методи навчання, учні, фізика.

INTRODUCTION

The problem of secondary school students' experimental skills developing during preparation of future research specialists has

been mentioned in the works of some Ukrainian and European authors [1], [2], [3], [6]. It is well known that Physics is an experimental science so the goal of the physics teaching does not

refer only on remembering the main formulas, it means not only reciting and enumerating basic laws of physics but also stimulating interest in experimental work [4], [6]. However during last decade bringing up to use modern computer technologies, an application of up-to-date computer programmes, modeling of physical processes by means of computer from one hand and lack of financial support for Ukrainian education from the other hand courses to the displacement of real physics experiments from the lessons at the 80 % of Ukrainian schools. Moreover at ordinary secondary schools in Ukraine physics experiments during the lessons or beyond usually are carried out with preassembled equipment. Also in most schools the experiments are run using pre-assembled instructions [7]. Those activities are definitely valuable and justified. But students who are interested in physics, technology or engineering as their future carrier should also have the opportunity to carry out projects they have planned, thought up and elaborated themselves. For that reason in our Laboratory which offers special support for realising those projects has been created. Besides, the primary and secondary school students (from 7–16) are encouraged to take part in local and international annual Conferences, Competitions and Tournaments with their experimental projects for secondary school children, their parents and university students where they can «touch science» and find out about very serious topics in an entertaining way.

V. N. KARAZIN KhNU — SCPT LABORATORY

V. N. Karazin KhNU — SCPT Laboratory has been created since 2007 as an institute of additional physics education.

The V. N. Karazin KhNU — SCPT Laboratory works with 23 Kharkiv Secondary schools, where we regularly demonstrate Popular Physics Lectures, which have the common name Paradox Show connected with a content of Official School Physics Curricular. During those lectures V. N. Karazin KhNU — SCPT Laboratory's research workers are able to select and choose the pupils (9–12 years old) who have capabilities for experimental work and invite them to join regular trainings on Saturdays at the Laboratory. Those selected primary and secondary school students

have regular (once a week) short theoretical lectures (45 or 60 min), giving by university teachers accompanied by practical training (90 min) by the leadership of university teachers or students. In addition all our students have special English course (two hours a week), where they learn Physics and Maths in English. It is a very important point of their preparation as future scientists. It is considered there are three stages of experimental skills development.

The first stage is for all comers primary school pupils from 9–11. At our theoretical training we proposed them 13 interactive theme physics lectures which have been elaborated by the V. N. Karazin KhNU — SCPT Laboratory colleagues. All of them have been adopted to the primary school pupils to be understandable for children of that age range. Every Saturday at the premises of the Laboratory one of the lectures (dur. 45 min) is presented to our visitors. The topics are interesting for children: Physics in Toys, Wonderful Mechanic, Travelling in Sound Land, Physics in the Kitchen, Light and Colours, Paradoxes of Magnetic Field, Wonders of Electricity etc. At the beginning visitors became acquainted with simple physics principals and laws and then they are able to do simple experiments themselves. After 5 months training they choose the topic and prepare their own simple research projects. They usually report about their first «scientific results» at annual University Conference «Junior Scientific Start-Up» in May. At the first stage they usually do simple experiments which are demonstrated and explained to the audience at those Conferences. This new approach is a successful attempt to show that it is possible to change pupils' and secondary school students views about physics with a relatively short but explicit methods (see Fig. 1).



Fig. 1. Simple research projects Sound Waves at the first stage

The second stage is for students from 11 to 14 who are selected by methods mentioned above from Kharkiv schools and lyceums. They are also involved in regular extracurricular (once a week on Saturdays) short theoretical lectures (45 min) and more serious practical training (90 min). During such experimental training students are taught to operate with simple tools like handsaw, boring mill, perforator, vernier callipers, tester. They design and help to produce some exhibits for Physics Exhibition [7] or for the events which organised in their schools (Week of Physics, Science Picnic, Night of Science) under the leadership of the students from the Department of Physics and Technology at the University mentioned above as also as V. N. Karazin KhNU — SCPT Laboratory staff. Such kind of practical trainings gain them a lot and their experimental skills are seriously improved by doing self-made experimental projects using recycled materials, simple household objects or ordinary toys (see Fig. 2).



Every year the V. N. Karazin KhNU — SCPT Laboratory staff works with 3 groups of students. There are 6–8 students in each group. They are divided according to their age range or secondary school forms. We also take into consideration their theoretical knowledge in physics and mathematics. Before they start they have to pass specially prepared short tests in Physics and Math (for the students from 13–16). It helps us to divide them into the appropriated and convenient for teaching groups. There were 5 research projects in 2015–2016 years. The best ones are followed:

- Simple experiments with sounds (first stage research project) reported in English by Daria Slobodina (12), Danylo Datsenko (11) and Andrii Konyk(11);
- Heron’s Fountain (second stage research project) made of ordinary kitchen plastic containers a non-typical pattern designed and produces by Anton Rusynnyk (13);
- Creation of the experimental set-up and



Fig. 2. Working with real tools and the example of hands-on Heron Fountain from the plastic boxes as a second stage project

The third stage of research skills development. The prevailing lack of interest in physics matters among adolescents from 14 to 17 is obvious and common not only for Ukraine but also for all developed countries [8]. It most notably manifests itself in the steady decline in the number of students at Physics Departments in all Ukrainian universities. The V. N. Karazin KhNU — SCPT Laboratory uses of the machine laboratories and the electronics repair laboratories at the Department of Physics and Technology, subject-specific support by scientists, lease of equipment has got lots of advantages not only in Kharkiv, but also Kharkiv Region.

demonstration of a «soap film liquid motor» which has been done by the students aged 16 Maksym Peretyaha and Vitaliy Yurko. All those projects have been done at V. N. Karazin KhNU — SCPT Laboratory (see Fig. 3).

The third stage projects are usually much more serious and can be compared with real Diplomas at University. The example is «Liquid film motor» [9]. In recent years scientists have become interested in the physics of liquid films. Study those films is the part of the interesting physics section called «Physics of Surface». When the films are subjected to the action of various chemical, thermal, structural or electrical factors, they display interesting



Fig. 3. Experimental skills development at the third stage

dynamical phenomena. Investigation of soap films and bubbles is very impressive topic in a lot of student research projects. A soap film should be formed on a flat frame. Place the film in an electric field parallel to the film surface and pass an electric current through the film. The film starts rotating in its plane (it can be seen in figure 4 below). The phenomenon have been investigated and explained (see Fig. 4).



Fig. 4. Elaborated liquid film motor measurements

CONCLUSIONS

Three self-made devices have been designed and created during 2015–2016 years in the Laboratory. During the extracurricular theoretical and experimental trainings mentioned above students have the opportunity to obtain an insight into the real research methods of investigation, to conduct their own research projects and demonstrate some of their KCs (for example basic competences in science and technology and communication in the foreign language) at the different local and international conferences (Bronze medal at International Conference of Young Scientists, April 2015, Izmir, Turkey). Teaching methods proposed by the authors are not contrary to the existing Ukrainian teaching techniques, they can be considered as an effective supplementation to traditional methods and forms of physics teaching. For more than 10 years of the Centre

existence 98 % of students entered in Kharkiv and some other Ukrainian Universities and became a good students and succesful scientists as in Ukraine as so as some European countries. We are proud of our ex-students who now are working in Germany, Canada, the USA, The Netherlands and Poland.

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