Materials of Conferences

PROBLEMS FACING TECHNICAL EDUCATION

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The issues of educational process in secondary schools as well as tertiary educational institutions are being widely discussed in press, as noted in the number of high school graduates with the highest possible 100-point score in the physics state exam has increased 26-fold in 2013 [1, 2]. The mean score in physics has grown from 52,28 to 60,12. As the academic year has only started, it is hardly worth making judgements about how much the students' knowledge has actually improved.

The prevailing trend in today's education is in rapidly changing education technologies, which proves that Russian education is in the bifurcation point. Before now, people who had just completed their degrees were in high demand in industry, which was an incentive for applying to higher educational institutions to major in technical engineering, while at present degrees in law and economics are more popular.

The Russian Ministry of Education has increased the target figures for admission to engineering and science degrees, trying to fix the situation. However, applicants' preferences are still biased towards economics, state governing, advertising and public relations. Recently, there has also been an increasing interest in medical biochemistry, while the real economy sector demands specialists in engineering and innovative technologies.

In this situation it is difficult to predict the results of changes in the educational process according to the foresight studies by the Strategic Initiatives Agency [3]. It states the following key features of the future education:

1. Total transformation of the educational process.
2. Personal education. Everybody chooses their own education trajectory. "There is no place for the old school and university in the future world".
3. Achievement storage – the portfolio system – is one of the key characteristics of the educational process.
4. Organising universities by a set of majors which group students together.
5. Lifelong education.

Whereas the ideas of achievement storage and lifelong education can be agreed with, the other points appear highly problematic.

For a secondary school student choosing subjects to major in for further education in a modern university is a serious challenge. As for abandoning organised study in schools and universities, it is worth remembering Freud's words that a human being's desire to work is just a fantasy.

Even more questions arise with testing the abilities of those applying for jobs in serious spheres of activity demanding high responsibility. Apparently, the following requirements will remain eternal truths whatever change may take place:

1. Knowledge of the fundamental laws of natural sciences.
2. Skills in applying it in solving professional problems using mathematical techniques and up-to-date software instruments.
3. Experience of research work with up-to-date professional equipment.

The organisation of educational process in university and school may be subject to a lot of further discussion, but if it provides in a university all the three points mentioned above and employers readily admit university graduates which demonstrate career progress, this university's practices deserve studying and promoting, and this institution is in no need of immediate changes.

The competency-based approach, which is widespread in assessing the quality of training not only university, but secondary school students, implies formulating, developing and assessing the competencies. All the three positions have specific problems associated with them. Employers are not willing to make their requirements widely known, preferring to find out about potential employees during interviews and probation periods. So, educational program developers are facing the risky task of formulating competencies based on consultations with employers and market demands, further coordinating them with those interested. For the developing competencies, in addition to the items mentioned before, it is necessary to have a corresponding educational program, organizing the educational process, etc. But the most challenging task is assessing the level of competencies after the completion of the study. This work includes a suggestion that not only the student's achievements in learning, but also research activities and research works published are assessed [4].

The rector of Lomonosov Moscow State University V. Sadovnichy indicated in one of his speeches that the information contained in physics coursebooks is 50 years behind the modern state of science. As physics is the basis of technical education, the teaching and learning process in physics plays the leading role. Its importance reaches the highest degree if physics is the student's major. The bachelors' and masters' curricula for the physics major specializing in condensed state physics have been enriched with two new courses: the Modern Scientific Picture of the World, the world-view-related course, and the Basic Physics of Nanomaterials to form up-to-date scientific ideas. Besides, studying these courses will enable the graduates to

change their professional direction in the future. In the ancient time, all the scientific disciplines were studied within one – natural philosophy. The differentiation between the disciplines was historically justified, which was proved by the rapid development of physics, chemistry and biology in th 18th, 19th and especially 20th centuries. As a result of this differentiation, the research trajectories of these disciplines went in different directions: by studying physics, chemistry and biology separately, the laws of functioning in al chemical and biological systems are examined. But this leads to the disappearance of the idea of the world unity; the world is universal because it consists of the same elements (no other elements have been found in space), it is ruled by the same laws (the subdivision to mega-, macro and microworlds is relative, and their applicability limits should be taken into account, etc.).

This is a reason for teaching a new «natural philosophy» which presents a common scientific picture of the world based on the most recent achievements of natural sciences. The course also includes common issues of natural sciences: the symmetry and asymmetry, the curvature of space, self-organization, etc.

Due to the development of the nanomaterials and nanotechnologies area, quantum mechanics has found practical application [5]. Of special importance are quantum mechanics sections for students specializing in the Condensed State Physics program. We consider it reasonable to begin presenting the informational material of the Basic Physics of Nanomaterials course with revising the concepts of solid state physics and to point out that Brillouin zones indicate the values of wave vectors at which an electronic wave cannot spread in the solid body and this is the physical idea of the zones. As a result of the crystal lattice periodicity and the existence of Brillouin zones, allowed and forbidden states emerge in the crystal.

The application of Fourier expansion for vectors of the reciprocal lattice of the periodic function with the translational symmetry of crystals can be explained by Fourier series being a powerful instrument for solving a variety of tasks. A very important component of the information material is classical and quantum size effects [6–8], which appear in quantum dots, wires, and tubes. The physics of nanoparticles' self-organization in physics, chemistry, and biology are studied beginning from the ideas of self-organization, conditions of self-organization, etc., with which students are familiarized within the Modern Scientific Picture of the World course, as mentioned above. The basic physics of spintronics is studied [9, 10] as well as application for high-speed logic circuits.

John Amos Comenius, the founder of modern education, emphasized the highest importance of revision and assessment. The former of these has already been realized. Assessment is performed on a regular basis thanks to the developed test-based assessment system [11]. The software for it was developed by the General Physics Department of National Research Tomsk Polytechnic University. The state registration certificate was obtained.

The assessment system facilitates all kinds of assessment in the Modern Scientific Picture of the World and Basic Physics of Nanomaterials courses, process, analyse and interpret the data obtained from the testing. It includes all the necessary and sufficient tools to provide the students' knowledge assessment in the classroom as well as during the self-study. If the state of physics education in most higher education institutions in Russia does not change, hopes for higher production effectiveness will not come true. However, there is place for hope based on the rising interest for physics and technical degrees, as is seen from press [12].

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