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ҒЫЛЫМИ-ТӘЖІРИБЕЛІК КОНФЕРЕНЦИЯСЫНЫҢ БАЯНДАМАЛАР  
ЖИНАҒЫ*

***СБОРНИК МАТЕРИАЛОВ  
ІХ МЕЖДУНАРОДНОЙ НАУЧНО – ПРАКТИЧЕСКОЙ  
КОНФЕРЕНЦИИ: «АКТУАЛЬНЫЕ ПРОБЛЕМЫ ТРАНСПОРТА И  
ЭНЕРГЕТИКИ: ПУТИ ИХ ИННОВАЦИОННОГО РЕШЕНИЯ»***

***PROCEEDINGS OF THE IX INTERNATIONAL SCIENTIFIC-PRACTICE  
CONFERENCE «ACTUAL PROBLEMS OF TRANSPORT AND ENERGY:  
THE WAYS OF ITS INNOVATIVE SOLUTIONS»***



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Тематика статей и докладов участников конференции посвящена актуальным вопросам организации перевозок, движения и эксплуатации транспорта, стандартизации, метрологии и сертификации, транспорту, транспортной техники и технологии, теплоэнергетики и электроэнергетики.

Материалы конференции дают отражение научной деятельности ведущих ученых дальнего, ближнего зарубежья, Республики Казахстан и могут быть полезными для докторантов, магистрантов и студентов.

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## UNIVERSITY METROLOGICAL EDUCATION: OPPORTUNITIES AND CHALLENGES

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### I Introduction

All for-profit organizations whose output are products, either goods or services, aim the same: increase revenues and reduce costs to increase the difference between the two, that is to say, to increase profit. Costs depend essentially on the organization while revenues depend mostly on the quality perceived by the receiver of the products, either clients, users or consumers, for short, customers. Quality, which can be defined as *the degree to which a set of inherent characteristics of an object fulfils requirements* [1], stresses the fundamental role of customers on the evaluation of goods and services. To maximize revenues and minimize costs, it is thus fundamental that organizations adopt management quality systems. Particularly in the case of goods, quality is associated to quantitative indicators, most of them resulting from the measurement of quantities, physical, chemical or others. That is the domain of Metrology, the *science of measurement and its application* [2].

### II Metrology

Measurements are essential to almost every aspect of human endeavours, as they are used in activities that include production control, assessment of the quality of the environment, health and safety, and the quality of materials, food and other products to ensure safe trade practices and consumer protection, to name a few examples. Metrology, the field of knowledge that deals with everything related to measurement and to its applications, is usually subdivided in three subfields:

**Scientific Metrology**, which deals fundamentally with international and national measurement standards, laboratory instruments and scientific research and methodologies related to the highest level of metrological quality.

Scientific metrology performs measurement units from definition, using science (physics and others), as well as fundamental physical constants, developing, maintaining and conserving reference standards. It operates at the level of the highest degree of accuracy and uncertainty, being independent from other entities in terms of traceability. The guarantee of the values obtained is strongly based on inter-laboratory comparison exercises among primary laboratories.

**Applied, Technical or Industrial Metrology**, which covers measurement systems responsible for controlling production processes and ensuring the quality and safety of final products. Industrial metrology operates in the scope of measurements of production and transformation of goods for the demonstration of metrological quality in organizations with certified quality systems. Measurements in the industry enable the quantification of the determinant quantities for the generation of a good or service, subsidizing with information the planning, production and management of the processes that produce it. Industrial metrology is based on a hierarchical chain of standards existing in laboratories and companies, standards that are traceable to primary standards (international or national).

**Legal Metrology**, which is the part of metrology related to activities resulting from mandatory requirements, referring to measurements, measurement units, instruments and measurement methods developed by competent bodies. Its main objective is to protect the consumer by dealing with measurement units, methods and measuring instruments, in accordance with mandatory technical and legal requirements. With government supervision, metrological control establishes adequate transparency and trust based on impartial testing. The accuracy of the measurement instruments guarantees credibility in the measurement systems used in business transactions and by systems related to the areas of health, safety and the environment.

Metrology and scientific and technical progress are inseparably linked, since, on the one hand, without accurate measurements, it is impossible to develop science and innovative technologies, and on the other, it is the achievements of science and technology that stimulate the development of measuring technology, the emergence of new methods and means of measuring various quantities. Because of this relationship, the actual tasks of modern Metrology must necessarily include those that ensure progress in all spheres of human activity, including science, technology, ecology, public relations, etc.

There is a problem of increasing the innovation and competitiveness of industry, including machine-building, chemical, pharmaceutical, and food industries. Now in chemistry, biology, and medicine, measurements are used to make decisions that can affect people's lives and destinies (based on DNA measurements, decisions are made to judge or not to judge a person, and paternity can be established). Nanometrology, Metrology in Biochemistry, and Metrology in Ecology are gaining momentum. Here we remember D. I. Mendeleev, who said: "Science begins where measurements begin." The importance of measurements for basic science has not been cancelled. Increasing the accuracy of measurements is one of the most effective ways for a person to understand nature.

### **III Metrology in the University: the ENU case**

At present, no country in the World aiming at development can reach that objective without putting in place a metrological system that encompasses both laws and regulations and organizations. Naturally, such a system cannot fulfil its purposes without adequate human resources. This means that it is necessary to have available metrological education, a special direction in education that can be characterized as innovative training of specialists in the field of technical regulation and Metrology.

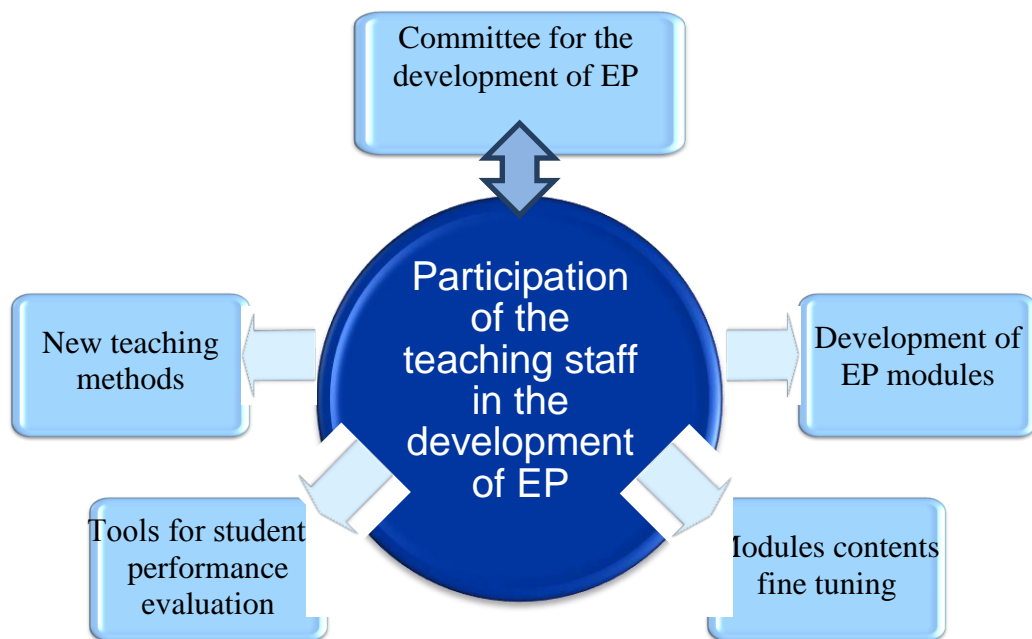
In Kazakhstan, in 2017, President Nursultan Nazarbayev launched the idea of the Third Modernization of Kazakhstan, which includes the tasks of technological re-equipment, industrialization, innovative development, and automation. The success of these tasks is impossible

without the participation of metrology, which provides the necessary accuracy and level of measurements.

Having that target in mind, in 2018, and at the initiative of employers, the educational program "Standardization, Certification and Metrology" of the Eurasian National University (ENU) was divided into two areas: "Standardization and Certification" and "Metrology".

In 2019, ENU received a license to prepare bachelors in the educational program "Metrology". The Department of Standardization, Certification and Metrology (DSCM) has made great efforts to achieve this. Together with employers, an educational program (EP) was developed, a new curriculum and accompanying documents were prepared, new equipment was purchased, and teachers underwent advanced training in the RSE "KazInMetr". This educational program has successfully passed specialized accreditation by the "Kazakhstan Association of Engineering Education KAZSEE". Students and faculty members of the DSCM actively participated in the development of the educational program. The DSCM has established a Committee for the development of educational programs, which includes employers, leading scientists, undergraduates and students. The process has undergone the following stages (Figure 1, Figure 2):

1. Creation of a Committee for the development of educational programs.
2. Development by professors and teachers of modules of disciplines based on professional standards.
3. Adjustment of the modules contents according to employers' inputs.
4. Development of tools for monitoring and evaluating students' performance.
5. The development of new teaching methods.



*Figure 1 – Metrology Educational Program (EP): tasks participated by the teaching staff.*

In our opinion, the revision of approaches to professional training of metrologists is more relevant today than ever and, thus, several points should be highlighted.

Equipping the educational process with tools is a big task. Purely theoretical training will be quite useless because Metrology is all about measurements and measurements involve practical activities, the knowledge of measuring methods, techniques and procedures, but also of instruments and the know-how of using them correctly.

We also believe that it is necessary to train metrologists in different specializations.

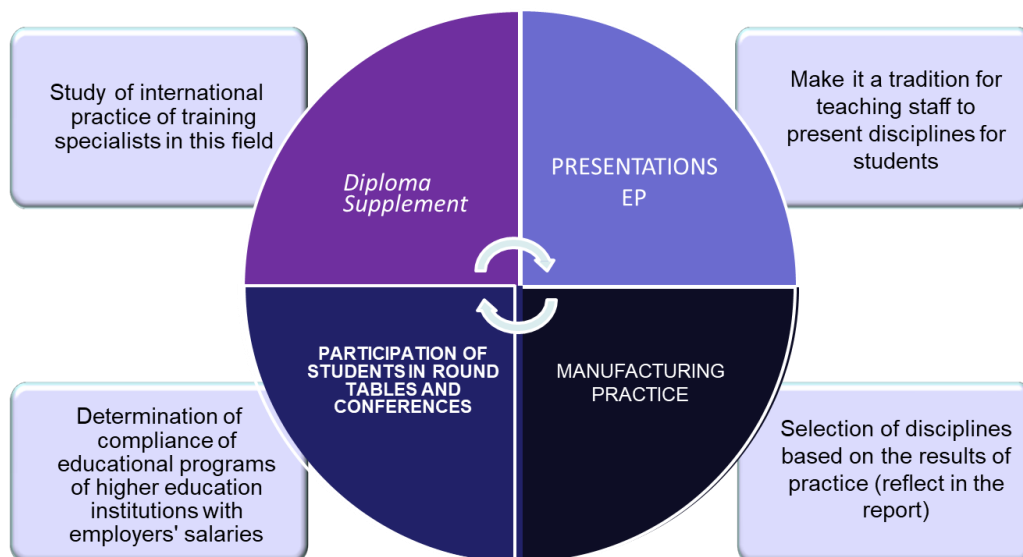


Figure 2 – Metrology Educational Program (EP): students' participation

Since in every field of activity, in every technology, there are different quantities that need to be measured, a future metrologist needs a lot of knowledge, including theoretical physics, statistical data processing, etc. This is a demanding specialty that is constantly being updated with new knowledge.

Thus, the problem of the quality of training specialists for professional activity becomes more and more significant in the context of building an effective industrial and innovative system for a country like Kazakhstan. The practical orientation of education is becoming increasingly important, which is expressed in the acquisition of practical skills by students. In this regard, contradictions between the needs of society and the opportunities of universities to train professionals are growing in the educational environment. Enterprises need highly qualified personnel for their successful activities, and universities, taking into account the demand in the labour market, need graduates who are successfully employed and of whom they will be able to be proud. It is quite clear that we will not solve this problem by ourselves, and we cannot do without the participation of employers. In order to solve this problem, the DSCM-ENU developed various tools for interaction with employers in the formation of a partner community. In our opinion, it is necessary to create a system where the employer can influence the contents of the educational program and participate in the educational process so that the graduates may have the right profile for the labour market.

In this context, the DSCM conducted a survey among employers on the relevance of the educational program "Metrology". As it turned out, employers are ready to participate in discussions at various stages of creating an educational program (86%), and their employees are ready to conduct classes for students of the OP "Metrology" (51%). According to the survey results, enterprises are ready to provide production sites and equipment for practical training (49%), their representatives are ready to participate in the final certification (36%). The survey also showed that enterprises are ready to fund the training of their personnel under this educational program in the future – 78%. The main part of employers (72%) believe that the new educational program "Metrology" will be useful for training high-quality specialists and for mastering new technologies.

Despite the successes achieved by the DSCM, the two-year experience of admitting students to this educational program has shown that there are problems here. In the 2019-2020 academic year, ENU recruited only 10 students, and in the same academic year, ENU did not manage to attract any candidates to this educational program. What is the reason? There is no doubt that the pandemic has had a negative impact on the recruitment of applicants, and we have not been able to work individually with each applicant. But in our opinion, career guidance work should be carried out on a systematic basis together with employers. It is fundamental for young people looking for a

future professional career to see in Metrology an attractive alternative, offering above-average financial retributions and personal fulfilment.

#### **IV Conclusion**

Metrology is a domain of multiple challenges and opportunities but of vital importance for any developed or under development country.

The organization of a national metrological system is fundamental to obtain positive results but no such system can do without the participation of qualified manpower. It is up to technical schools, universities in particular, to prepare graduates with adequate formation, which should be done in close collaboration with the society, namely with industrial enterprises.

As it happens worldwide in most technical domains, people can only be attracted to Metrology if they perceive a career well paid and personally rewarding.

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### **ОПЫТ РАБОТЫ МЕЖЛАБОРАТОРНЫХ СЛИЧЕНИЙ В КАЗАХСТАНЕ. ФИНАЛЬНЫЕ РЕЗУЛЬТАТЫ ПО ОПРЕДЕЛЕНИЮ pH В БУФЕРНОМ РАСТВОРЕ**

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**Актуальность статьи.** Участие в межлабораторных сличениях является одним из обязательных условий для подтверждения технической компетентности лаборатории в соответствии с ГОСТ ISO/IEC 17025-2019, одной из форм управления качеством результатов измерений в лабораториях (п. 7.7 ГОСТ ISO/IEC 17025-2019). [1]

Межлабораторные сличения являются необходимым и действенным инструментом обеспечения единства измерений в стране и качества измерений в лабораториях. Межлабораторные сличения - организация, выполнение и оценивание измерений или испытаний одного и того же или нескольких подобных образцов двумя или более лабораториями в соответствии с заранее установленными условиями. [2]

Рассматриваемые в настоящей статье межлабораторные сличения проведены по графику проведения МЛС на 2020 год. [3]

Целью работы являлось проверка компетентности лаборатории по средством межлабораторных сличений. Предметом проверки является технологическое, информационное и методическое обеспечение прослеживаемости измерений в испытательных лабораториях (ИЛ).

Проверка было направлено на оценку сопоставимости результатов лабораторных измерений в ИЛ при определении pH в буферном растворе.

В межлабораторных сличениях приняли 10 ИЛ.