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"IT IS NOT FORBIDDEN TO DREAM… NOR TO COUNT TALES" METROLOGY EDUCATION FOR THE YOUTH

Dilhermando Augusto de Mello [1]; *Luciana A. Almeida Carvalho* [2]

[1,2] Rede Metrológica de Pernambuco - Remepe, Recife, Brazil, rempe@pe.senai.br, lucianac@pe.senai.br

Abstract: XVIII IMEKO World Congress presents the paper METROLOGY EDUCATION FOR THE YOUTH. The work addresses among one forms playful to present the metrology **fundamentals** and the main scientists who contributed with their discoveries, research and measurements, throughout the evolution of the human being and the technology.

1. INTRODUCTION

The paper is a result of a request from the National Industrial Apprenticeship Service (Serviço Nacional de Aprendizagem Industrial - SENAI), which is the largest educational centre in Latin America, linked to Brazil's National Confederation of Industry (Confederação Nacional da Indústria - CNI).

SENAI developed the SENAI Metrology Management Programm, which includes Metrology as a subject in all its vocational training courses. Producing, disseminating and adapting technology and know-how for Brazilian industry as a whole, SENAI provides a vocational training in many different fields, while also rendering services designed to modernize enterprises and endow them with a keener competitive edge [1].

As part of the material used in the metrology education for SENAI, the work "*It is not forbidden to dream... nor to count tales"* was written that, in a playful manner, introduces and makes perceivable the evolution of the science of the measurements and its presence in the citizen´s formation [2].

As result, the work contributed for elaboration of a didactic material, that was developed in multimedia [3]. This interactive tool became recommended to the professional education of metrology, especially for young apprenticees[1] from the 16 years old [4].

Keywords: Education, metrology, scientists.

[1] The industrial learning of basic level or technician destined to the qualification or initial qualification of young apprenticees and are based in a solid formation of citizens and a professional formation that its insertion in the work market makes possible.

2. METODOLOGY

The present work followed the same methodological framework applied to the text above mentioned, then the paper has as main objective to present for the young people about concepts of the metrology and its permeability to the others sciences. Therefore, the paper searched to create a fiction, to keep the interest of young readers for the subject.

The informations presented throughout the fiction are real and based on scientists´ histories, obeying a chronological order of the main scientific discoveries associated to the science of measurement.

3. BRIEF DESCRIPTION

The history is initiated with a trip of six young people, in a balloon, without a destination to the edges of the Mediteranean Sea…

Later, we see far a mirage with two pyramids and one third in construction. We were impressed with the conference of the blocks of rock with rectilinear poles very and equally marked to the long one of its length. Always following the river, we found many other lesser pyramids, sfinges, and other constructions. Thus, we saw a country called Egypt. We were impressed with the rigid symmetry of the workmanships. The accuracy of measurement was sensitive to our eyes.

Going towards Mesopotamia, we perceived a great flow of merchants. The people were essentially farmers and produced a great amount of grains that were sold in containers, possibly of copper or bronze, in exchange for uniform currency, not only its size, but its formats and details. But it was in Babylon that we found a gorgeous and huge construction: they were the *Hanging Gardens of Babylon*, we were for much time admiring the gorgeous architecture, with very correct dimensions.

Then, after some years we had a chance to know a people characterized by its justice traditions and individual freedom, the Greeks had established the bases of the democracy. We were impressed with the enormous projected columns by the architect *Fídias*, based on the theorem of the mathematical celebrity *Pitagoras*. In the Greek theater, half-circular outdoor structure, silence impressed us, allowing us to hear perfectly the perfomance of the artists. While in Greece, we visited four temples where there were kept and conserved the standards of measure for use of the government and the people: ***the Sciade***.

In Rome, we were informed that in the **Middle East** a young preached the equality between men. A new age began, since then, the years had 365 days after the death of *Jesus Christ*. Four centuries later, emperor *Constantino* almost edited the decree for the measures called ***Mensura Capitulina***. The standards were deposited in two well secure sacred temples. Some time later, the emperor ordered copies for all the cities and commanded that they were kept in the main temple.

After a violent wind that destroyed our balloon, we decided to follow proper destinations. We already had good knowledge on currencies, measure of length, weight and volume. Carrying one laptop and electronic calculator, we decided that our contacts from the *Middle Age* would be kept by e-mails or mobile telephone.

Again in the Mediterranean, in Eleventh Century, Antonio informed us that he had found an instrument brought by the Arabs whom indicates the magnetic North very close to the true one. Fernanda, that was in England, informed us that the king *Enrique I* decreed the value of the ***Yard*** as in the distance between his nose and his finger of his hand. Still in England, Fernanda, informed that, this time the king *Enrique VII* fixed the first units of weight and measure in 1500.

In the Sixteenth Century, Gustavo communicated us that the Portuguese mathematician *Peter* ***Nunes*** using an auxiliary ruler (***nonio***) was able to read fractions of the main one. In France, *Pierre* ***Vernier*** enhanced the invention by making a sliding ruler, giving origin to the ***paquimeter***. In 1643 in France, Gustavo informed that the scientist *Evangelista* ***Torricelli*** constructed the ***mercury barometer***.

Fernanda, who was in England, told us that the physicist and mathematician, *Isaac* ***Newton***, had emitted the ***law of universal gravitation***. Also, the discovery of *Robert* ***Hooke*** on ***periodic oscillation*** in a spring revolutionized the clocks, giving to them better accuracy.

From Dantzig, Antonio informed us that the physicist *Daniel Gabriel* ***Fahrenheit*** had manufactured the ***mercury thermometer*** in 1720. Shortly afterwards, in 1724, the physicist *Anders* ***Celsius*** proposed a ***centesimal thermometric scale***.

Jessica, now with Fernanda, told us that *James* ***Watt***, in 1769, patented the ***Steam Engine***, based in the *Newcomen´*s engine of 1712. England was speeding up with scientific development. In 1843, *James Prescott* ***Joule*** established the mechanical ***equivalent of heat***, having been elected in 1850 for the Royal Society.

In France, the physicist *Armand* ***Fizeau*** measured the ***speed of light***, later measured with better accuracy for the doctor *Jean Bernard Leon* ***Foucault*** who created the ***pendulum*** proving that the Earth resolves around itself.

In London, Fernanda had known a physical nobleman who received the heading of *Lord* ***Kelvin*** and, among his innumerable works, created the ***thermometric scale*** where the absolute zero was to a temperature of -273,16 ºC.

The Academy of Sciences approved the adoption of the ***Metric System***, during the French Revolution, by the mathematicians, ***Lagrange, Borda*** and ***Condorcet*** and chemistry ***Lavoisier***. Because of the power of the ***jacobines,*** the resignations had initiated and not satisfied, they had started to arrest and guillotine all fee collectors, include ***Lavoisier***, although he was not, he was decapitated. In 1848, *Jean-Louis* ***Palmer*** constructed to an equipment with great accuracy, giving origin to the ***micrometers***.

The Industrial Revolution in the Eighteenth Century was responsible that the English measures, also used for the United States, rised as industrial power, dominating the mechanics measurement. At this time, we decided to live in Paris, it sharpened us it curiosity for Brazil that had already adopted the ***Metric System Decimal***. Reason for popular revolts, the people thinking that with the change of the *pole* for the *meter* they lost length. The revolt of the ***break-kilos*** destroyed meters and kilograms in the commerce.

In 1870, it was installed in Paris, the first *Comité international des poids et mesures* (CIPM) and adopted the ***Metric System***. In 1872, the CIPM comes back to congregate and decided that, after the war Franc-prussian, the kilogram of the standards of the ***Archives de France*** would have to be corrected and made of platinum-iridiada, a league of 90% of platinum and 10% of iridium. The decision most important, however, was the creation of the *Bureau International des Poids et Mesures* (BIPM), with headquarters in Paris and kept by the interested countries. The conference culminated with the *Convention du Mètre*, in May 20th, 1875, and participation of 21 countries, including Brazil [5].

In the beginning of Twentieth Century, we decided to live in Brazil. This country had a very controversial relationship with the *Convention du Mètre*. In 1921, it was reintegrated to the *Convention*. In 1931, it was moved away again and in 1953 it came back to reintegrate itself. Despite of this, we were told of the formation of great national laboratories, as *Physikalisch-Technischen Bundesanstalt* (PTB), in Germany, the *National Institute of Standards and Technology* (NIST), in the United States and the *Instituto de Pesquisas Tecnológicas* (IPT), in Brazil [6].

In 1960, we were told that the XI *Conférence Générale des Poids et Mesures* (CGPM) decided to adopt the ***International System of Units (SI)*** and, in 1971, the XIV CGPM adopted as units base of this system the units of the seven base quantity: *length, mass, time, electric current, thermodynamic temperature, amount of substance and luminous intensity.*

In 1973, in Brazil, the creation of a National System of of Metrology, Standardization and Industrial Quality (SINMETRO) and the National Institute of Metrology, Standardization and Industrial Quality (INMETRO) were an important cycle for the primary metrology in Brazil. SINMETRO having the merit to congregate in an only system the instruments and the basic functions of the industrial technology, taken model as paradigm for other countries [7]. In 1991, the creation of the first state net of metrology became reference for creation in others states, being incorporated to the Sinmetro.

In 1995, with the foundation of the Brazilian Society of Metrology (SBM) scientists and professionals had engaged effectively in the metrology.

By these last facts, we are no longer spectator, to carry out in this fascinating movement for the development of the metrology, recognized as strategical instrument of the competitiveness and improvement of the quality of life.

4. CONCLUSION

The SENAI Metrology Management Programme has induced in environments of education and applied research of the SENAI, the metrology practical effective, mainly: (i) the use of the International System of Units (SI); (ii) the expression of uncertainty in measurement as the ISO-GUM and (iii) the evidence of the traceability of the working standards to SI, for intermediary of calibrations in accreditaded laboratories or laboratory intercomparisons.

Due to the multidisciplinary nature and importance of this subject, the introduction of the subject metrology of playful form in the different levels of educational formation, especially in most basic of the pedagogical hierarchy, can be seen as solidary to the long process of maturation and formation of the citizen.

We strongly recommend that the told experience serves of paradigm for other initiatives, becoming soft the knowledge of the metrology in the Brazilian society.

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