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A CENTENARY OF THE BIRTH OF PROFESSOR CHRISTO IVANOV

Abstract. The article presents the life story of the well-known Bulgarian organic chemist and university lecturer Professor Christo Ivanov as researched by members of his family. The author is his son who was Head of the Department of Organic Chemistry at the Medical University of Sofia. The paper contains a review of the principal achievements in Prof. Chr. Ivanov's scientific work, amply illustrated with the respective chemical equations and accompanied by detailed analysis. Finally, a full list of Chr. Ivanov's publications is presented.

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CONTEXT-BASED CHEMISTRY LAB WORK WITH THE USE OF COMPUTER-ASSISTED LEARNING SYSTEM

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Abstract. The paper aims to show how the context-based approach can be applied to teaching the analytical chemistry course to the university students with major in food processing technology and food expertise. The article describes the principles that underlie the context-based teaching and innovative approaches to structuring analytical chemistry lab work using the computer-assisted learning system (CALS). Finally, the paper presents the results of testing this resource in the context-based lab work, and discusses its impact on developing relevant professional competencies in university students.

Keywords: context-based learning, information technology, lab work, food safety, chemical analysis of food products.

Introduction

The reform of higher professional education in Russia and many European countries is based on a strategy involving the implementation of a competence-based qualification model. Parchmann et al. (2006) write: "the definition of competence given by Weinert points out an important aspect: competence is not just based on cognitive understanding and abilities, but also on motivation and willingness to apply these to different problems, interacting with other people."

The competence approach promotes context-based learning and requires the creation of an innovative educational setting which combines modern technologies, primarily information technologies, and insures highly effective educational process. Nowadays this is particularly important as, on the one hand, in many countries there is a concern of declining interest among young people in math and science studies[1,2) (Jerrim & Choi, 2014; Toshev, 2014; Kostova, 2015). On the other hand, there is stronger demand for a multidisciplinary approach to the study of various natural and social processes and to the development of modern technology (Toshev, 2012; Mc Goldrick et al., 2013; Piunno et al., 2014). In this context, the most promising perspective is to create an interactive environment which enables to manage the information about how students learn, and how they acquire relevant understanding and skills. An essential characteristic of such an environment is practice-based nature of all types and forms of teaching and learning, especially in science education with fundamental content knowledge. Context-based learning (CBL) has long been an essential attribute of an effective teaching process, as it allows universities to train specialists with a broad body of knowledge and transferrable skills. Opportunities and the need for teaching a context-based science (chemistry) course have been widely investigated and reported in educational literature (Bennett et al., 2005; Bennett & Lubben, 2006; Hofstein & Kesner, 2006; Parchmann et al., 2006; Peterman, 2008; Forest & Rayne, 2009; Luck & Blondo, 2012; Mandler et al., 2012; Peteva et al., 2014). This approach also finds its application in practice, in Ural State University of Economics (USUE) (Ekaterinburg, Russia).

USUE offers Bachelor and Master degree programs validated by the Ministry of Education and Science of the Russian Federation in the following areas of specialization: Commodities Expertise, Processing Technologies and Public Catering, Vegetable and Plant-Based Foods, Foods of Animal Origin, and Biotechnology.

The food industry (food production and consumption) is growing all over the world, which generates a high demand for qualified workforce in the labor market. In this context, the development of genetic engineering, the use of genetically modified products, intensive commercialization of the food sector, and the scope of risks in the economic and social segments are increasing, and the issue of food security is becoming more acute all over the world (Yngve, 2012; Pant, 2014; Kolar, 2014). In order to resolve the problems, undergraduate and graduate programs are built around relevant professional competences. In Russia professional competences are set in the Federal Standard of Higher Education. The Standard states that the development of nationally recognized competences must be ensured through the study of relevant disciplines, in our case, Analytical Chemistry and Physical and Chemical Methods of Analysis. This course is one of the core science modules and is characterized by both theoretical and applied approaches.

An essential element of the course is lab work as it brings CBL in the science classroom. It allows students to be engaged in the experimental activity thus enhancing their deeper knowledge acquisition, developing critical thinking, creativity and research skills. Modern lab work involves the use of information technologies and electronic resources, which helps to handle complex equipment and carry out numerous routine calculations.

For the last seven years the USUE Department of Physics and Chemistry and the Department of Statistics, Econometrics and Informatics have been jointly working on designing a computer assisted learning system (CALS) (Stozhko et al., 2014). The CALS was first introduced in the analytical chemistry studies in 2013. It consists of a set of modules (software programs). Each module is aimed at student acquisition of specific skills. Currently the CALS includes 30 modules that are registered as computer programs with the Federal Institute of Industrial Property (FIPS). The system is constantly being improved and updated with new modules. Lab work with the use of the CALS contributes to the development of professional competences set in the educational standards and cognate to the specialism. Thus, the purpose of the paper is to put teaching and learning of analytical chemistry and physical and chemical methods of analysis in line with modern educational approaches. This article has the following objectives: to work out principles of innovative context-based lab work with the CALS application; to tailor CALS modules to learning objectives and competences, and to test lab work within the CALS.

Methods

The methodology used in this work includes three aspects: (1) The design of e-resources within the CALS and their implementation in the analytical chemistry lab work; (2) The arrangement of lab work and student training in the chemical analysis of food within the CALS; (3) The assessment of learning carried out with the use of innovative tools, including the CALS.

The design of e-resources is based on interdisciplinary teaching and learning (Bortnik & Stozhko, 2013; Stozhko et al., 2014), which is gaining its popularity due to the benefits it brings into the classroom (Lukman & Krajnc, 2012). Universities are testing various models of cross-disciplinary relationship in the science and engineering class (Dekhane & Tsoi, 2010; Goldberg & White, 2014). In USUE the interdisciplinary project involves the collaborative work of students and teachers from the Department of Statistics, Econometrics and Informatics; and the Department of Physics and Chemistry.

Lab work is arranged around professionally oriented subject matter teaching (Ball et al., 2008; Coldham, 2011). This approach implies that teaching and learning focuses on the issues of the subject that are essential for developing professional competence in individuals. For example, for the food industry the core professional skills are ability to conduct chemical analysis and to use up-to-date equipment and techniques. This hands-on experience is the core of lab work.

Our methodology of assessing students' achievements included, firstly, the results of interim and end-of-semester tests[3)]; secondly, comparison of achievements of two student groups: students who used the CASL and students doing more traditional lab work; and finally, surveys of both teachers and students.

Results and discussion

The lab work model has been drawn on a number of principles: (i) the context-based approach which determines the construction of the lab work on the basis of practice-oriented goals tailor-made to future profession and the solution of life problems; (ii) problem orientation which implies consideration of relevant and important issues and shifting the focus from the work-related knowledge and skills to the solution of pressing problems; (iii) continuity which allows to combine innovative electronic resources with traditional experiments; (iv) a variety of incentives to successfully complete the task; (v) the modular approach that implies relative autonomy of individual modules, blocks of modules, module components, and the sequence of the module study; (vi) regular control that focuses on diagnosis and assessment of student achievements; (vii) the creative approach as student independent study aims to develop creative thinking and to form creative potential.

In our opinion some concern that the use of the CALS may turn lab work into a virtual experience has unreasonable grounds. Experimental work is an essential component of the analytical chemical studies, as it creates learning setting for students to gain relevant skills, e.g. how to handle up-to-date instruments and equipment. Computer-assisted lab work provides more opportunities to better address educational objectives, namely: (a) information is visualized, which ensures better perception and understanding; (b) information is transferred from the teacher to the student faster, thus optimal solutions are made quicker; (c) presentations skills are developed and mastered, which contributes to the students' ability to apply mathematical models, analyze, synthesize and critically appraise results; (d) students are able to conduct experiments using relevant algorithm, identify and resolve problem issues, develop critical thinking and creativity.

A critical component of professionals' activity in the food sector (production engineers, bio-production engineers, merchandise and foods experts) is to assess the quality and safety of raw materials, semi-finished and finished food products. In order to gain applicable knowledge, understanding and skills in the analytical chemistry and methods of analysis, the programmed lab work includes the use of the CASL for analyzing a wide range of non-alcoholic and alcoholic beverages (bottled juices and mineral water, wine and cognac). The quality of packed juices (apple, pear, etc.) was measured by using the conductometric analysis and the relevant software (the Auto-Analysis Module). The experiment is performed with juices with different 'produced' dates. The titration curve is plotted, and the obtained curve shape allows students to make a conclusion about the content and concentration of fermentation products in the juice, i.e. the quality of the sample drink and its suitability for consumption. This type of an experiment contributes to the acquisition of such skills as identification, assessment of quality and safety of products, detection of hazardous and counterfeit products.

Measuring iron content at different stages of wine and cognac production and in the finished product is an important analytical task, due to the fact that excessive iron can result in wine turbidity and bad taste. To familiarize students with appropriate methods of analysis two modules - Wine-FEC Module and Fe-FEC Module - were added to the CALS. These are software for photometric determination of iron: ferric thiocyanate complexes in white wines (Wine-FEC Module) and ferric ferrocyanide in cognac (Fe-FEC Module). The software allows students to process the results of the experiment using relevant statistical methods. Thus, students are able to determine the concentration of a given element in the sample, compare it with the standard (maximum permissible concentration (MPC), and draw conclusions about the quality of the product.

The Express-Analysis Module makes it possible to analyze bottled mineral water with different degrees of mineralization and can be used for quick detection of counterfeit mineral drinking water. The software allows students to determine carbonates in the sample using both neutralization (acid-base titration) and conductometric titration simultaneously. Students study norms and regulations, compare the data in the producer certificate with the results of the analysis, and then make a conclusion about safety and quality of the product or make recommendations for further sanitary-hygienic monitoring. The module includes a set of algorithms to assess the accuracy of the results obtained by the two analytical methods. This enables to quickly process the results and to obtain a final result with a calculated error. Fig. 1 presents the screen shot of the Express-Analysis Module. The experimental data of conductometric titration are shown in the upper left corner; the titration curve and the calculation of hydrogen ion concentration - at the bottom, and the results of the analysis of three samples of Arkhyz mineral water - in the upper right corner. The data were obtained by using neutralization and conductometry simultaneously.

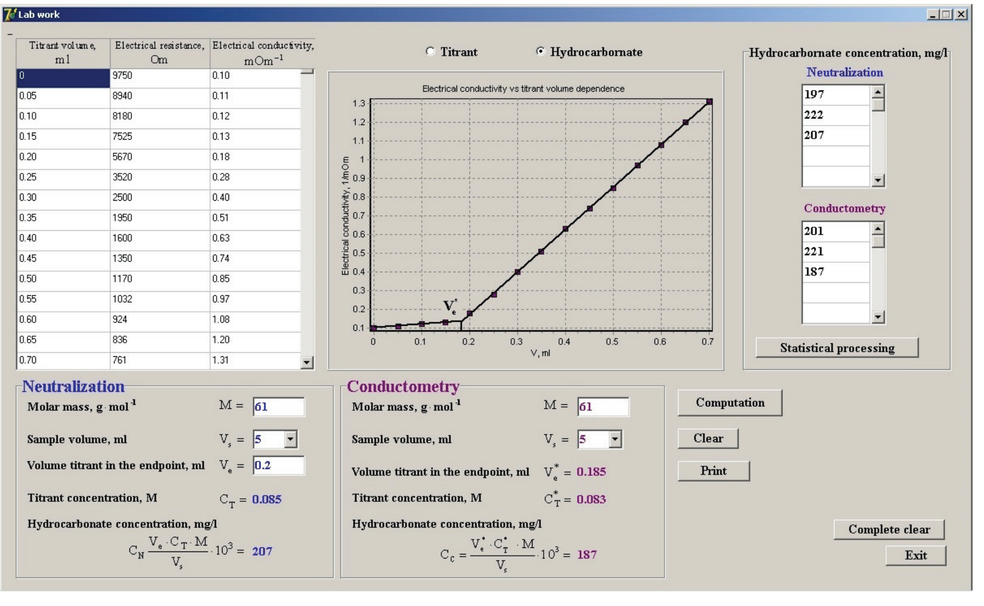

Fig. 1. Screen shot of the Express-Analysis Module with experimental, calculated and graphical data of measuring bicarbonate ions in three samples of Arkhyz mineral water, obtained by using neutralization and conductometry

Fig. 2 presents the screen shot of the Express-Analysis Module with the statistically processing results of the Arkhyz mineral water analysis obtained by using neutralization and conductometry simultaneously. Comparison of these data proves identical reproducibility of the two methods and insignificant systematic errors. It allows for the possibility of combining the samples of the two methods in one group, whose relative error is lower than that of each sample's. Concentration of bicarbonate ions in Arkhyz mineral water obtained by the use of the two methods does not exceed the values stated in the producer certificate (100-300 mg/l).

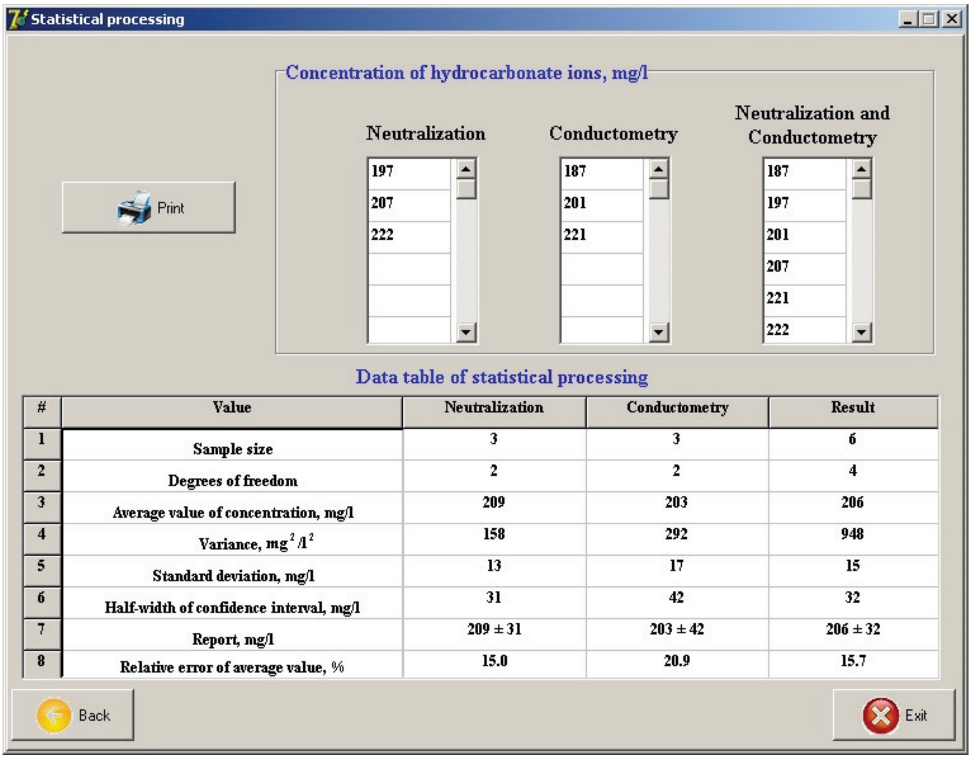

Fig. 2. Screen shot of the Express-Analysis Module with statistically processed data of measuring bicarbonate ions in three samples of Arkhyz mineral water, obtained by using neutralization and conductometry

The presented lab work familiarizes students with different aspects of their future professional performance thus encouraging students to develop applicable and transferable knowledge and competences. It increases learning motivation by engaging students' curiosity and interest in the subject. From that point of view it can be considered one of the solutions to the problem of enhanced students' motivation in chemistry (Gendjova, 2014).

Essentially lab work can be looked upon as a model of an experiment (a scientific test), hence, the need for presenting the findings. The research report should include introduction with the purpose of the report, problem statement, aims and objectives, description of methodology (procedure), results with an assessment of their accuracy, discussion of the results and conclusions.

Thus, students learn how to practically apply software to the analysis of food products. The use of these programs makes it possible to exclude routine calculations, to eliminate the risk of errors, and to present the final results in accordance with the metrological norms and requirements.

Students' involvement in software design and the application of program-based resources in professional teaching and learning are the two sides of a unified system, which creates an innovative educational environment. Students were assessed on-line by a four-level testing scale during the semester and at the end of the semester. The comparison of the achievements showed that among the students who used the CASL over 60% attained Level 3 and Level 4 while only 40% of the students doing more traditional lab work achieved the same results. Twelve teachers were encouraged to share their two-year experience of running the analytical chemistry lab work with the use of the CALS. Teachers reported that they found the lab work more motivating to teach, that their students were more interested in the analytical chemistry studies in general and were able to select an appropriate method of food analysis and effectively use it. Teachers also commented that this contributes to the acquisition of the core disciplines of a professional cycle, in particular, Introduction to Metrology and Standardization.

In order to receive feedback from students, a short self-development survey was used. Students rated the degree of their interest in chemistry, complexity of the subject, and how chemistry applies to the world around them by a 10-score rating scale (10 being the highest). The data gathered from 86 students showed that an average score was 8. The majority of students commented that practicing chemical analysis of various products helped them to better understand the applicability of analytical chemistry to food safety and quality control. Though testing results and surveys of both teachers and students were not subject to extended statistical research, they do reveal positive impact of the innovative lab work model on student achievements.

One outcome of using the CALS in the analytical chemistry lab work and thus mastering modern experimental methods of chemical analysis is that students learn how to conduct research and present their findings to the scientific community. For the last two years USUE students have participated in seven academic events: XII

International Symposium and Exhibition "Clean Water of Russia", Ekaterinburg, 2013; International Contest of Young Researchers "Food Security", Ekaterinburg, 2013; National Competition "Stand-up Science", Novocherkassk, 2014, and others.

Conclusion

Context-based approach has become the most important attribute of teaching and learning. It is essential for developing individual's professional competence and being competitive in the international labor market. In order to build the essential competences for the effective food safety sector, the USUE Department of Physics and Chemistry has created an innovative educational setting. It is based on the principles described in this paper. These principles are universal and useful for pursuing context-based learning in science. An essential component of the USUE educational setting is an innovative process based on the computer-assisted learning system (CALS) for the analytical chemistry studies, which includes programs (modules) for carrying out chemical analysis of food composition and implementation of professionally oriented student learning. The context-based analytical chemistry lab work with the use of the CALS appears to have been a successful course innovation judged by its uptake and the findings of research studies into its effect on students' interest and understanding of the experiment. Students' achievements suggest that this type of learning enhances professional competencies in future specialists in the food sector.

More important answers will be given after a longer period of time when the new approach will have to become normal.

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NOTES

1. http://www.aspacnet.org/apec/research/_pdfs/OECDJapanSeminarOgura050624.pdf
2. http://www.theguardian.com/news/datablog/2013/dec/03/pisa-results-country-best-reading-maths-science
3. On-line testing was introduced at the Department of Physics and Chemistry in 2011 and presents a four-level scale. Levels of knowledge and skills attained are: 1: 0- 49%; 2: 50-69%; 3: 70-89%; 4: 90-100%.

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