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How can the analytical chemistry training develop transferable personal and professional skills?

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ABSTRACT

The changed institutional and social characteristics require, besides technical and technological training, students also to have a wide range of social skills, including the so called skills for professional competence (employment). Modern engineering and technology training brings educational objectives closer to the expectations of business. The technical and personal skills must be developed as transferable skills for a better career. This guides the processes of modernization of training to the development of skills and competences in response to the needs of the users/employers. Thus, the system of the higher engineering education can ensure that during the course of training the students will receive the appropriate basis for further professional development. In this paper a model for the development of integrated skills is applied in analytical chemistry exercises and extracurricular activities are considered - results from the end of the exercises in analytical chemistry.

Keywords: analytical chemistry training model, transferable skills, employability skills, self-assessment, peer assessment.

INTRODUCTION

Essentially, the social skills are transferable and multifunctional. They are applicable - can be used in solving different types of problems and performing different types of tasks. That is why they are a key factor to improving employability and successful professional and social realization.

The emphasis on personal components is placed in order to give the students more functions within the learning environment and this is done systematically in order to develop skills for individual representation self-assessment criteria, and the ability to identify a wider range of environmental components, as a reference in their own activity [1].

Direct learning activities should be implemented within the training process like real work situations and a direct observation of a phenomenon or a process. This will provoke reflective thinking, students will analyze the situation, as well as to define problems. In the process of

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dialogue and discussion, ideas and models will be chosen for solving, and the ways to achieve the objectives will be defined and justified. In the course of the activity a continuous feedback is carried out, which leads to corrective actions, analysis and evaluation. Assessment of the results is provided by the lecturer, but students also perform self-assessment and peer assessment.

Research on the skills of the students

During the period from 2013 to 2016 at the University of Chemical Technology and Metallurgy (UCTM) was developed a model of integrated skills development (technical and personal skills) in "Analytical Chemistry". A research of students' skills to apply knowledge has been made. It has extensively been tested – in exercises and extra activities. In order to meet the survey objectives, the process of acquiring knowledge and skills is being monitored and guided. The learning activities and the objectives are clearly defined in order to ensure the expected results. Clear and more easily measurable assessment criteria are created. A special focus is placed on forming self-assessment and peer assessment skills.

During the research the Biggs Model - prediction - process - product, and its corresponding taxonomy was applied. Biggs recognizes the fact that the cumulative assessment is important for certification as well as for monitoring the effectiveness of trayning/learning and that the formative assessment is important for identifying and verifying development and potential [2]. The conceptual framework of learning follows the concepts of an integrated curriculum [3], which includes learning activities and experience of students, provides the acquisition of subject knowledge and its application in professional activities.

Throughout the experiment didactic materials are introduced to form and assess key competences as a part of the work/employment skills. An Employment Skills Map has been drawn up, which provides proper self-assessment and teacher assessment. The map complies with the students' educational level and the requirements of the discipline and the curriculum. It covers four areas as learning outcome components. All skills contain detailed information about the indicators included, as well as criteria for their assessment. New elements are added to the assessment: self-assessment, peer assessment, portfolio, comparison of student and teacher assessment results.

The inclusion of the Wiki-liki platform in the experimental design of the Analytical Chemistry Course allows stimulation of activity, responsibility and precision in the process of learning new knowledge and it also provides proper environment for self-assessment and peer assessment. Wiki-liki allows collection of statistical data from the application of certain work methods on different criteria. Presentation skills are measured against previously set criteria and real cases are solved. The results are visible and legitimate.

Components in the experimental methodology:

- Solving a common problem in chemical laboratories;
- Team training;
- Work instructions;
- Establishing Assessment criteria;
- Monitoring and control of the students activities;
- Creating a portfolio;
- Self- assessment and peer assessment (peer review) of the results: assessment of the laboratory activity according to preliminary announced performance criteria; Assessment of solving computational tasks; presentation assessment on key subject topics from study material.

Authentic or integrated assessment tasks often require students to demonstrate a set of cognitive and metacognitive skills and to apply significant amount of knowledge and transformation experience. These tasks encourage students to integrate and apply their knowledge in the context of practicing profession, so attempts to find innovative proper assessment methods, both valid and reliable, do make sense[4].

Sadler emphasizes the role of the learner in the assessment process and views student self-esteem as the most important for improving student education. This requires that students possess an appreciation of what high quality work is, that they have the evaluative skill necessary for them to compare with some objectivity the quality of what they are producing in relation to the higher standard[5]. The peer assessment and self-assessment are related to the reflective practice because this process involves self-regulated development and as such is an important skill for career development and management [6].

RESULTS

Results from the test of the model at the end of the Analytical Chemistry exercises are published in this paper. The survey data collection tools are validated questionnaires and checklists. There is clustering when presenting external evaluation (by a teacher), the students' self-assessment and comparisons.

Following instructions on how to work and observe the activity of the students, at the end of the exercises, 40 students (bachelor's degree) and Analytical Chemistry teacher were interviewed on 13 components of the learning outcomes. Each student makes his self-assessment of all questions, in the survey, and assesses the other students within the group. Self-assessments are marked with the variables from x1 to x13. The average grade of the students from the administrative group on the i-th question for the respective student is marked with si. The effects for each student are assessed by the teacher having in mind the same questions, with variables y1, ..., y13 [7]. Fig. 1 and Fig. 2 give the histograms of questions with „close" and „divergent" answers.

„Close" / Similar are the charts of the assessments of questions 1 and 5 (knowledge and academic experience); 10 and 11 (personal skills), 13 (work skills), Fig. 3.

Fig. 4 shows two highly distinct linear diagrams. Student self-assessments differ greatly from the teacher's assessments about to apply knowledge and personal skills.

Larger discrepancies in assessments on indicators „Critical Thinking", „Problem Solving", and „Teamwork Skill have been also reported in the analysis of the results. The teacher's assessment does not coincide with the average student assessment on the following components: 2 (critical and analytical thinking), 4 (problem solving), 7 (written report), 9 (teamwork) and 11 (performance and engagement). Researchers argue that there are problems with the inclusion and the forming of employment skills in higher education [5]. The research

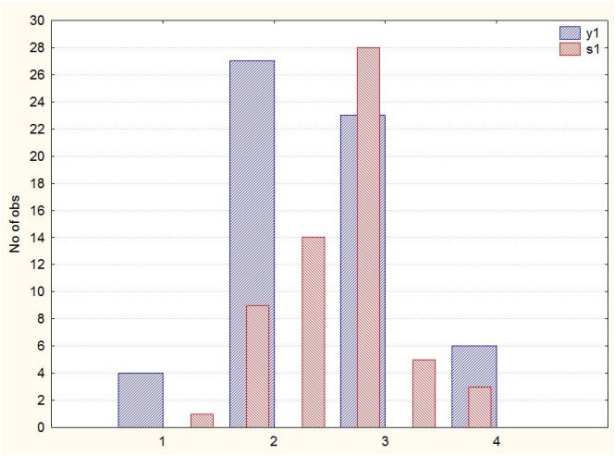

Fig. 1. Histograms of Teacher's Ratings and Average Student Assessment of c.1 (Mathematics, technical disciplines, analytical chemistry).

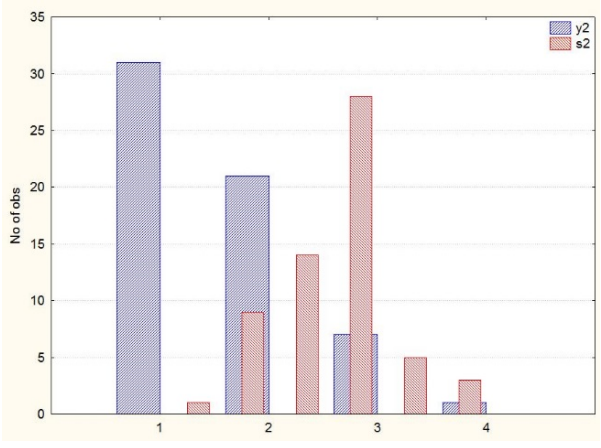

Fig. 2. Histogram of Teacher Ratings and Average Student Assessment of c.2 (Critical and Analytical Thinking).

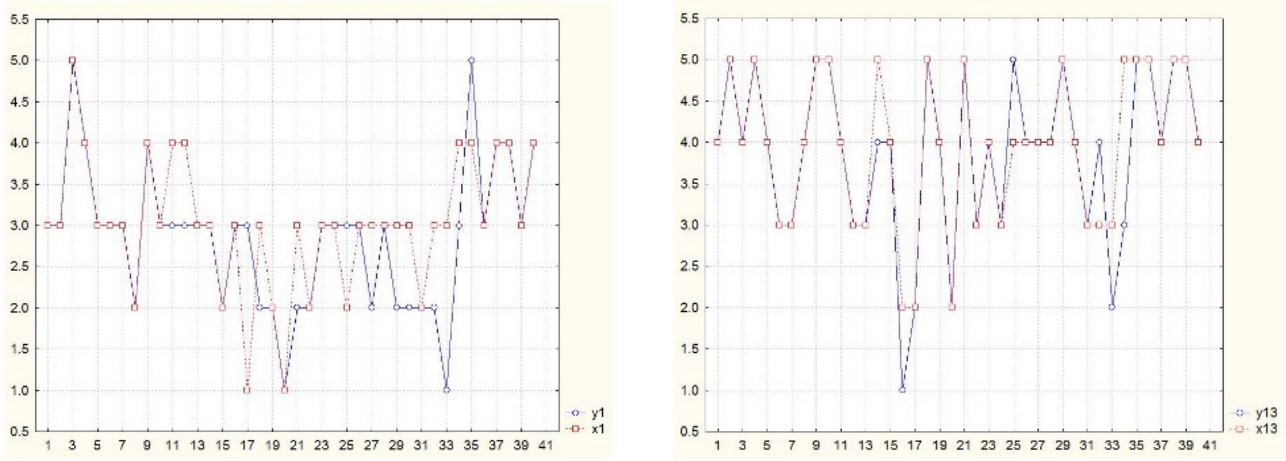

Fig. 3. Linear diagrams of students self- assessments and lecturer assessment on issues 1 (knowledge and academic experience) and 13 (work skills).

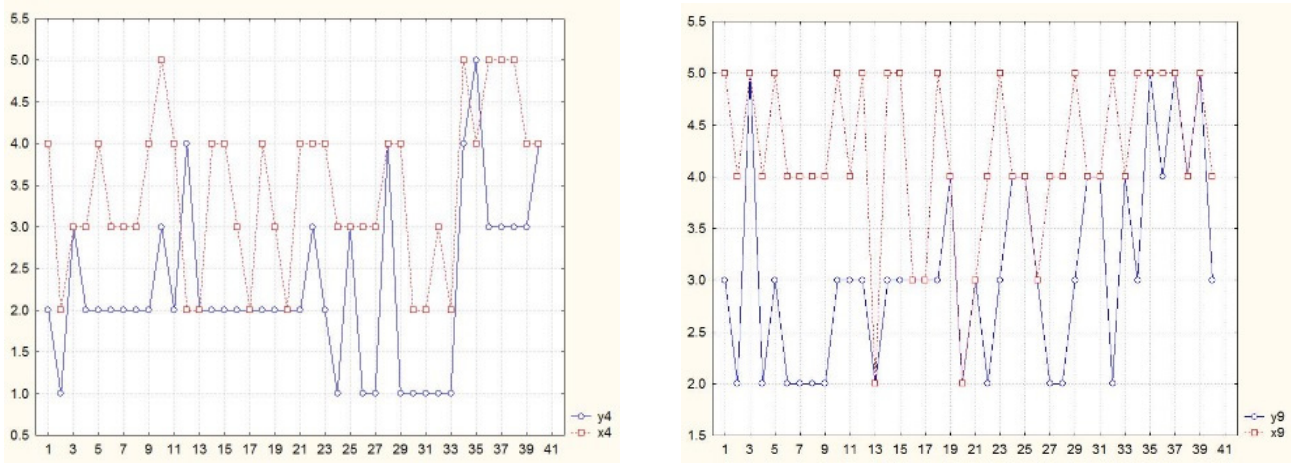

Fig. 4. Linear diagrams of students self-assessments and lecturer assessment on question 4 (knowledge and academic experience) and question 9 (personal skills).

clearly shows that students make efforts to develop their skills when the learning process provokes their thinking. They endeavor to perform tasks when given clearly defined assessment criteria.

CONCLUSIONS

Emotional and volitional sustainability, individual style of work are important features of applicable skills. The greatest challenge to higher engineering education in terms of developing social and professional skills is finding appropriate assessment models that can support and complement the rationalization of learning.

It is recommended the assessment should be regularly integrated with teaching and learning and students should be considered to be active participants in the process [8]. The overall conclusion is that students have problems while monitoring their own strengths and weaknesses.

Applying effective teaching and learning strategies, improving assessment procedures in engineering and technology training stimulate motivation and help skills transformation. For engineering and technology subjects/disciplines, the essential feature of learning activity is the transformation and transfer of theoretical knowledge in certain contexts. In summary, all this means that learning tasks should be as similar as possible to the respective professional realization [1].

The skills acquired in the learning process can complement and enrich the professional profile. The latter being interpreted as a "structured qualitative description of the professional's essential characteristics" [9]. The professional profile is a means of measuring competences and includes, besides qualification characteristics, sustainable thinking processes - planning, flexibility, and transferability of the thinking.

REFERENCES

1. S. Terzieva, Contemporary Educational Strategies. Orientation of Teaching in Engineering and Technology Specialties, Sofia, 2003, (in Bulgarian).
2. J. Biggs, Teaching for Quality Learning at University Buckingham UK: SRHE and Open University Press, 1999, https://inclusive-teaching.wikispaces.com/Biggs%27s+work+1
3. F. Edward, Rethinking Engineering Education: The CDIO Approach, 2014.
4. R. Murphy, Assessment Series No.5 A Briefing on Key Skills in Higher Education, 2001.
5. D.R. Sadler, Formative assessment and the design of instructional systems, Instructional Science, 18.2, 1989, 119-144, https://link.springer.com/article/10.1007/BF00117714
6. S. Traikova, S. Tsolova, How students understand the relation between forms of assessment and motivation, Science, Engineering & Education, 1, (1), 2016, 167-172.
7. L. Nilkolova, S. Terzieva, J. Angelova, A model for training in analytical chemistry on the basis of technical and personal skills and employment competences, Science, Engineering & Education, 1, (1), 2016, 160-166.
8. L. McDowell, Students and innovative assessment. Resource area of the Institute for Learning and Teaching in Higher Education file:///E:/Liz_McDowel_students_and_innovative_assessment.pdf
9. Y. Rasheva-Merdjanova, M. Bogdanova, European Career Education and the National Perspective, Avangard Prima, Sofia, 2012, (in Bulgarian).