PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013
74

IMPLEMENTATION OF PROCESS-TARGETED ACTIVITIES OF PROSPECTIVE CHEMISTRY TEACHERS DURING CONTINUOUS TEACHING PRACTICE: A RATIONAL COMPARATIVE ANALYSIS OF TEACHING METHODS ACCORDING TO THE EXPRESSED COMPETENCIES

Darinka Sikošek, Kornelia Žarić
University of Maribor, Slovenia
E-mail: darinka.sikosek@uni-mb.si, kornelia.zaric@um.si

Abstract

The main aim of the teacher study program is to ensure the proper role of teaching practice, which is included in initial teacher training courses. It is necessary that teachers of chemistry gain or develop learner competencies for appropriate teaching/ learning in the chemistry subject by using innovative teaching methods. In terms of activities and methods correction of the continuous teaching practice model for prospective chemistry teachers in Pedagogical study program of 2nd degree "Educational Chemistry" which would ensure the creation of a competent chemistry teacher (active and innovative).The main result of the study is a list of potential competencies by prospective chemistry teachers using innovative teaching methods. These competencies can be developed and produced in the performance of activities defined by using continuous teaching practice, particularly in the areas of testing and assessment, experiential and collaborative learning, and experimental (laboratory and field) work. Each of these components is separately assessed by activity and competence.
Key words: *continuous teaching practice (role), innovative teaching methods, learners' competencies, potential competencies by prospective chemistry teachers.*

Introduction

In the field of education there is a need for the provision of professional competence one of the key qualities of a teacher as a professional what requires a shift in emphasis from content to competencies. The confluent teaching practice of prospective teachers certainly has a central place in the process of undergraduate education and teacher training. Only then comes to interconnection of acquired theoretical and experiential knowledge, which means that function as a mutual source of information about the teaching (Cvetek, 2002).

Undoubtedly, continuous teaching practice (TP) offers to prospective trainee an opportunity for the implementation and development of teachers' professional activities, from planning and design of operating objectives as well as constructing methods and strategies to achieve these objectives (Moussay et. al., 2011).

Of course, prospective teachers (including chemistry) as trainees acquire and develop the necessary competencies through the implementation of the program activities. Effective implementation of diverse pedagogical activities (didactic, methodological and educational) requires

ISSN 1822-7864

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

mastery of innovative teaching and learning methods. Theory-based implementation of each teaching method is based on selected competencies of teaching. It is now necessary to highlight the link between the activities of prospective trainee and innovative teaching and learning methods used for the implementation of these activities. Particular attention should be paid to the effectiveness of practice, therefore, it is necessary for prospective trainees to assist in developing their ability to analyze their teaching and learning and appropriately improve and adjust this practice (Sandholtz, 2011). In the pre-service preparation, the school teacher-mentors are non-replaceable because they are the ones that encourage critical analysis and evaluation of the integration between theory and practice that classroom trainees implemented in the classroom directly (Sim, 2006). Work of school teachers as mentors remains an established partnership model, as well as a reflective learning model for prospective trainees (Haggera et.al., 2008).

Problem of Research

Competency analysis carried out in the framework of the Tuning project represents the answer to the question of which competencies contribute most to the effective professional functioning of future graduates. This analysis along with a set of key competencies common to all teachers also includes subject-specific competencies (Québec Education Program). Of all of these competencies there are some of which a prospective teacher cannot develop without learning in an authentic environment, represented by continuous teaching practice (CTP). Thus, the teacher competencies in the frame of CTP are defined as those which prospective teacher largely produces and develops during CTP. These competencies can be categorized into the following areas of teacher activities: didactic-methodical, communication, creation of professional self-esteem, student supervision and management of teaching and narrow subject area. (Juri evec et al., 2007). The objectives of TP teachers of the program Educational Chemistry 1st, 2nd level: integrated 7-day observational practice, 7-day deployment practice (primary education (PE) and secondary education (SE)), 14-day continuous TP (PE, SE) (Lemut, p. 30-32).

Initial mastery of didactic approaches (teaching methods) and work strategies (eg. project work, teamwork, experiential learning, research teaching) is the most important component of the competencies to be acquired / deepened by the student during continuous teaching practice. This is followed by testing and evaluating knowledge and internal learning differentiation. However, in contemporary professional practice, reflection is gaining great importance. Regarding the realization of objectives (set by curricular reform) is that this reflection was also reflected in the requirement for simultaneous selection of optimal methods of teaching and prospective teacher learning.

Research Focus

From the research carried out by Razdevšek-Pučko (2004) findings show that principals of primary schools in Slovenia, considering weaknesses of their teachers-beginners, indicate that they are not proficient in contemporary teaching approaches, they lack practical knowledge, are not qualified to transfer theory into practice, have insufficient knowledge of new approaches to testing and assessment and implementation of the principles of teaching, called internal learning differentiation.

Literature indicates a wide layout of competencies, but for the needs of pedagogical activities the classification, which differs key (Halasz, Michel, 2011; Key Competences for Lifelong Learning, 2006) generic (Australian Education Council, 1991; Gevorgianienė et. al, 2012) and subject-specific competencies (Québec Education Program. Cross-curricular

Competencies; Razdevšek Pučko and Rugelj, 2006) are topical.

Generic competencies (also known as subject-independent competencies that an individual develops in particular ways of working) is presented in the report of Mayer Committee (1991) which introduces the following fourteen competencies: (1) gathering information, (2)

analysis of literature and information organization, (3) interpretation, (4) synthesis of conclusions (5) learning and problem solving, (6) transferring theory into practice, (7) using mathematical ideas and techniques (8) adapting to new situations (9) concern for quality, (10) individual and team work (11) organizing and planning of work (12) verbal and written communication, (13) mutual interaction, (14) ensuring safety at work.

Subject-specific competencies represent a typical feature of the particular subject, for example. chemistry, where pupils / students acquire and develop a series of chemistry subject competencies (Žarić, Sikošek, Golob, 2009), especially the following capabilities: (1) knowledge of chemical terminology, nomenclature, conventions and units, (2) integration of macroscopic perceptions of explanation on a microscopic level and records on a symbolic level; (3) knowledge of the structural properties of chemical elements and their compounds and stoichiometry; (4) evaluation, interpretation and synthesis of chemical information / data (5) interpretation of laboratory data observation and measurement of their importance and linking them with related theories; (6) knowledge of digital (including numerical, arithmetic) competencies and analysis of errors and internet communication for the purpose of operating the chemical information and data; (7) knowledge of information competencies, including getting online available information from primary and secondary data sources; (8) knowledge of competencies necessary for the proper conduct of standard laboratory procedures and the use of instruments in the synthesis and analysis in the field of organic and inorganic systems; (9) knowledge of safety handling with materials and the laboratory procedures and the capability of assessment of risk factors in the use of these; (10) demonstration (use of) knowledge and understanding of the essential chemical facts, concepts, principles and theories in solving (un)known qualitative and quantitative problems; (11) understanding the environmental issues, assessment of risk factors using chemicals and implementation of laboratory procedures, as well as measures to prevent and reduce pollution; (12) awareness of key issues in the field of chemical research and development; (13) planning, preparation and execution phases of applied research identifying problems through the acquisition and integration of information and data (from primary and secondary sources) to the evaluation of the results and conclusions using appropriate techniques and procedures.

Since the teacher should act as a facilitator and designer of quality learning and stimulating learning environment, thus the consideration of working methods that would be optimal for the implementation process of target activities in the field of chemical education during continuous TP represents the central problem of this research.

The problem of research is defined into two key questions:

(1) What are the basic methods of effective initial training of trainee Chemistry teachers ?

(2) Which generic and subject-specific competencies can trainee teachers gain or develop in the implementation of these methods?

Methodology of Research

General Background of Research

The experience of continuous TP, performed in an authentic learning environment is as an irreplaceable component of the undergraduate training of future teachers (including chemistry). Innovative learning methods are a guide to successful learning and in continuing the successful operation of the vocational area and efficient to cope with the challenges of personal acceptance and placing the specimen in a given social environment. Both one and the other (learning / studying) as well as the operation of this entity in the social environment requires the mastery (competence) of a series of skills and capabilities. The implementation of diverse activities such as content filler-step construction of learning / working methods to the acquisition of competencies and continuing daily activities. Here, a direct alliance between learning / working methods and exercise in the consistent application of innovative methods in the educational process during the continuous TP is represented.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

Sample of Research

The sample of the empirical research was represented by a material (Diaries of continuous TP) from 23 prospective teachers enrolled in the 4th grade of undergraduate pedagogical double major study programme Chemistry and ... (... meaning one of the alternative subject areas, for example Biology) at the Faculty of Education, University of Maribor in the academic year 2007/2008. Those prospective teachers had already completed a 14-day continuous TP in the field of PE and SE (in addition to common observations and self-taught lessons as the previous forms of practical training).

As the research model of rational analysis of teaching methods were selected contemporary methods, which increase pupils' curiosity and consequently motivation for learning and activity and creativity. Expressed competencies that allow both partners (teacher and student) to get actively involved, to evaluate and improve, thus served as a key criterion of the range of innovative teaching methods.

Instrument and Procedures

The starting point for the design of teaching competencies are competencies that teachers will develop in their students. To this end, a list of competencies (Peklaj, 2006) was developed and revised by the expert group of the Faculty of Arts in Project Partnership of Faculties and schools. This list defines the teacher's competencies in terms of its activities, for example teaching, etc.). Students, teachers and trainees should make the shift to teaching methods that provide / allow particular: achieving higher taxonomic objectives, including hypothesis testing, achieving emotional and motivational objectives, including imagination, identification and weighing of values and creating a vision for the future (Ivanuš-Grmek, M., Čagran, B., Sadek, L., 2009, p. 34), acquisition of knowledge through their own experience: self-planning, monitoring and controlling process (ibid., p. 29, 34), encouraging reflection of one's own work and generating new knowledge, group cooperation, dialogue, interaction and feedback (ibid., p. 33).

Crucial in the selection of the optimal teaching method of prospective trainees during continuous TP were findings of the competence analysis identified in self-analysis of self-taught lessons (three self-taught lessons in the field of primary and secondary education). Trainee teachers carried out self-analysis of performed lessons by using analytical instruments (Polutnik, 2005), which include didactic and methodical area, especially the methodical process of learning process and the pedagogical-psychological knowledge and competencies, as well as content knowledge.

The data of this study is represented by didactic parameters included in the internal template - Analytical instrumentation of student's self-taught lessons (Polutnik, 2005), which represents the component of the material called Diary of continuous teaching practice. For in-depth student's self-analysis of their self-taught lessons was used the above mentioned analytical instrumentation, broken down into the following aspects of the educational process (especially teaching): (a) didactic characteristics, (b) a methodical course of the learning process, (c) pedagogical-psychological characteristics of teachers and students.

Data Analysis

The basis of successful teaching of chemistry teachers represents both gaining new as well as developing existing competencies either generic or specific for chemistry subject area. So didactic's analysis of student's self-analysis records represents a valuable feedback to both partners of practical training course of future teachers.

In view of teaching as a core activity of prospective trainee a set of selected methods

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

includes the following four categories of methods and their implementing forms:
(a) Assessment methods (Table 1: evaluation folder, oral examination;
(b) Methods of experiential knowledge (Table 2: problem solving, teaching with examples;
(c) Methods of cooperative learning (Table 3: project work (as experimental work, interviewing, project task);
(d) Chemical experimental methods (Table 4: laboratory experimentation, field experimentation)
Presented tables (1-4) show the results of this analysis which includes a selected method, a detailed specification of implementing forms within this method with defined procedural stages and corresponding competencies in occurring frequencies (Table 5).

Results of Research

A Set of Fundamental Methods of Effective Initial Chemistry Teacher Training

To illustrate the empirical qualitative analysis of expressed competencies concerning methods of work which can be in self-analysis of performed self-taught lessons are findings of four cases of competencies shown in figures 1-4.

Three-stage descriptive rating scale with labels: unexpressed - partially expressed - expressed, with each of these assessments descriptively defined, was used. For example, the text of competency assessment "partially expressed: "Selected competence is only partially expressed in self-analysis. Typically, the student performs the analysis of the competency only at the level of interpretation or just randomly mentions that he/she tried / used the method / work form / teaching tool / cross-curricular link / psychological knowledge ..." in self-analysis critical analysis and the development of the competence cannot be detected. (Lemut, 2013)

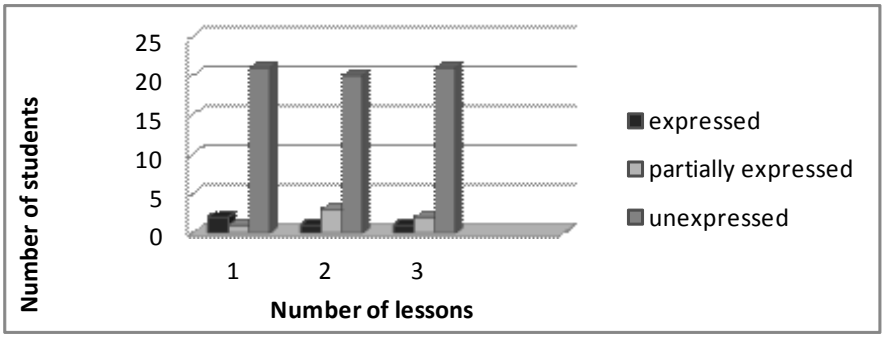

Figure 1: Competence: Competence and management of approaches in the area of testing and assessment of knowledge, student performance, and designing feedback.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

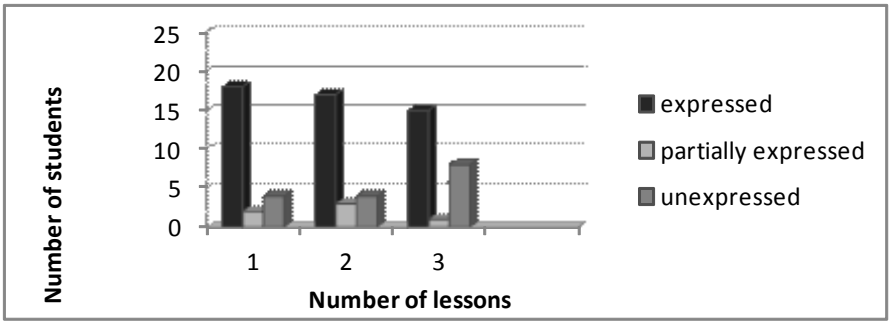

Figure 2: Competence: Knowledge and mastery of methods and forms of work, especially contemporary methods of teaching, using didactic and methodical knowledge.

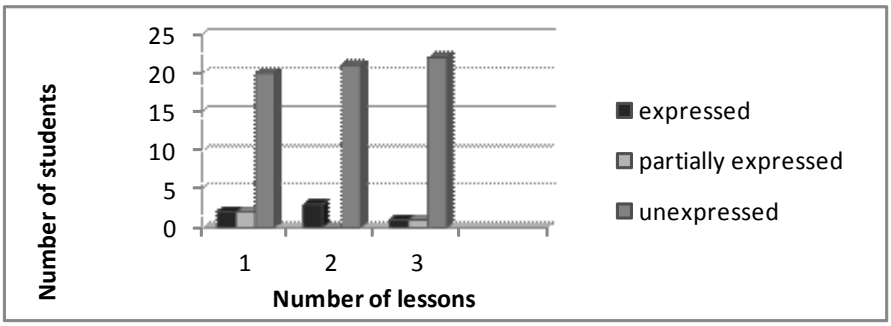

Figure 3: Competence: Positive orientation to new teaching approaches, particularly forms and methods of teaching, using project work, cooperative learning, multi-level instruction.

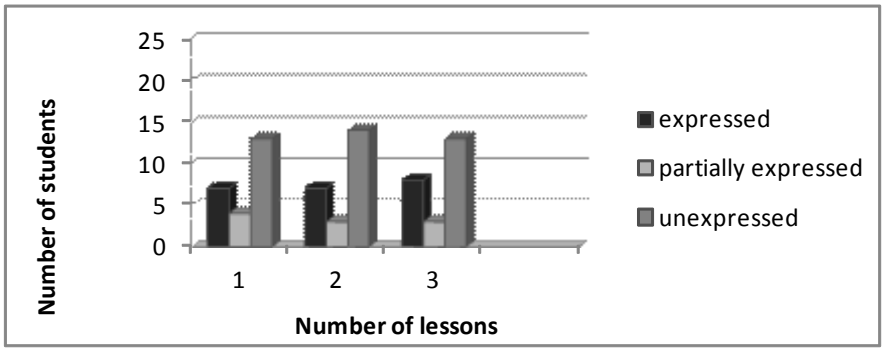

Figure 4: Competence: Ability to design target combinations of methods and forms of work with the support of learning resources.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

An Analysis of Trainee Teachers' Competences in the Implementation of the Set of Fundamental Teaching Methods

Each of the implementing forms defined within a teaching method (a to d) is stage articulated and has defined competencies necessary for successful teacher implementation of these stages. Defined competencies are also classified (see notation in brackets), using the above-mentioned list of generic and subject-specific competences within the chemistry subject area (see Research Focus). The results of rational analysis of working methods in terms of required competencies of chemistry trainee teachers are presented in Tables 1-5. Legend codes in brackets: competence area (GC, CC) and serial number of competence (GC (1-14), CC (1-13)).

Table 1. Competencies of chemistry student trainee teacher required for the implementation of selected methods of evaluation work.

(a1) Using the evaluation folder
The introduction of an individualized approach to the process of teaching, learning and assessment
(1) Knowledge of working with different groups of pupils / students. *(GC 6)* (2) Knowledge of the psychological characteristics of pupils/ students. *(GC 11)* (3) Promoting active learning of pupils / students. *(GC 9)* (4) Motivating pupils / students to learn. *(GC 5)* (5) Teaching on higher mental levels, including understanding, research and problem solving. *(GC 5; CC 11)* (6) Effective planning, organization and performing learning activities. *(GC 11)* (7) Encouraging self-reflection and self-evaluation skills of pupils / students. *(GC 9)* (8) Giving feedback to pupils / students of the acquired knowledge and training to advise on the planning of pupils' / students' progress. *(GC 3)*
Encouraging evaluation, professional self-reflection and critical thinking
(1) Planning, monitoring, evaluation and control of own professional knowledge during continuous TP. *(GC 3)* (2) Motivation for continuing professional development and professional collaboration by getting to know yourself and disseminating professional knowledge to help students to raise awareness and differentiated professional interests. *(GC 9)*
(a2) Use of the oral examination: *Generic competencies (GC), Chemistry subject competence (shortly CC)*
Design of examination tasks
(1) The composition of differentiated tasks. *(GC 6)* (2) Construction of tasks that develop logical thinking. *(GC 9)*
Evaluation of results
(1) Getting used to objective assessment and giving pupils / students feedback on the assessment. *(GC 3)* (2) Active participation with pupils / students. *(GC 13)*

Table 2. Competencies of chemistry student trainee teacher required for the implementation of selected methods of experiential learning.

(b1) The use of problem solving method: *Generic competencies (GC), Chemistry subject competence (shortly CC)*
The introduction of interdisciplinary integration of content and thus getting used to the approach of the overall problem solving
(1) Ability of interdisciplinary teamwork. *(GC10)* (2) Developing good relationships with pupils / students & other employees. *(GC 13)* (3) Training for collaborative problem-solving and teamwork. *(GC 5.10)* (4) Training for individualization and differentiation of instruction. *(GC6.11)* (5) Encouraging pupils / students for logical reasoning and evaluation of solutions. *(GC 5)*
Introducing actualization of content

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

(1) A critical assessment of developments in the field of natural sciences and application knowledge to meet the vocational and daily living needs. *(GC 5)*
(2) General knowledge, ability to communicate with experts from other professional and scientific fields. *(GC12)*
Interpretation, integration and evaluation of information and data
(1) Developing autonomy in professional work. *(GC 10)*
(2) The use of ICT in education. *(GC 2, CC9)*
(3) The ability of independent search of information. *(CC2)*
(4) Demonstrating initiative, ambition, continuous evaluation of personal advancement and professional training. *(GC 9)*
Understanding and solving quantitative and qualitative problems
(1) Use of natural and mathematical thinking for qualitative problem solving in nature, environment and society. *(GC 3)*
(2) Encouraging pupils / students to solve basic problems in chemistry by using scientific methods. *(GC 2; CC1)*
(3) Organize an active and independent pupils'/ students' learning and training for effective learning. *(GC 5; CC 1)*
(4) The ability of analytical and synthetic thinking and understanding of the basic concepts of chemistry. *(GC 4)*
(5) Deductive derivation of new logic conclusions from the available data. *(GC3, CC 10)*
Checking the knowledge and performance of students and the design of feedback
(1) Demonstration of communication skills and giving feedback to pupils / students. *(GC 12, GC 13)*
(2) Ability to create a positive learning climate and motivate pupils / students to participate. *(GC13)*
(3) Ability to intense activation of prior knowledge of pupils / students. *(GC 1)*
Evaluation of solutions
(1) The ability to restructure knowledge mastered by the pupils / students by using the method of problem solving. *(GC 9)*
(2) Ability to promote interest in and need for further lessons learned (contextual learning). *(GC 5)*
(b2) The use of learning methods with examples: *Generic competencies (GC), Chemical competencies (shortly CC)*
Developing responsibility of pupils / students for their own lifelong learning
(1) The ability of planning tasks and choosing examples which require critical thinking of pupils / students.*(GC 3,9)*
(2) Asking questions which answers requires pupils / students to reflect upon their own knowledge. *(GC 3)*
(3) Encouraging pupils / students for researching, thinking about what they have learned. *(GC3)*
Solving basic professional problems by finding sources of knowledge and application of scientific methods
(1) Use of natural and mathematical thinking for qualitative problem solving in nature, environment and society. *(GC 7, 9)*
(2) Encouraging pupils / students to search for information from a variety of sources (books, including foreign literature, experts, internet, ...) *(GC 1, CC 9)*
(3) The use of scientific methods in their own work, and encouraging pupils / students to use them. *(GC 9)*
(4) Promotion of curiosity, activity and thinking in pupils / students. *(CC 11)*
Ability of oral and written communication and teamwork
(1) Encouraging pupils / students to report on what they have learned and discovered and the evaluation of their competencies.*(GC 12, CC 3)*
(2) Ability to check the knowledge and achievements of pupils / students and design feedback.*(GC 12, 13)*

Table 3. Competencies of chemistry student trainee teacher required for the implementation of selected methods of cooperative learning.

(c) The use of project work method: *Generic competencies (GC), Chemistry subject competence (shortly CC)*
Developing social skills of pupils / students
(1) Encouraging pupils / students for mutual cooperation, negotiation and consideration of different opinions and ideas. *(GK 13)*
(2) Coordination of conflicts among pupils incurred during the implementation of learning activities. *(GK 13)*
Introduction of pupils / students to active work
(1) Promote active and independent learning that enables pupils / students to plan objectives and activities to achieve the planned objectives, monitor, evaluate and regulate their own learning. *(GC 10, 13)*
(2) Using a variety of approaches to maintain the motivation of pupils / students. *(GC 11)*
Enabling the differentiation of instruction
(1) Knowledge and application of methods for working with different groups of children. *(GC 6)*
(2) Consideration of interests and needs of the pupils / students. *(GC 8)*
Encouraging cooperation between pupils / students, teachers and other employees

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

(1) Management of leadership and organizational skills in educational work. *(GC 11)*
(2) The ability of collaborative problem solving and team work *(GC 5, 11)*
(3) Taking active steps to encourage the learning of pupils / students. *(GC 6)*
(4) Developing good relationships with pupils / students and other employees. *(GC 13)*
(5) Ability of interdisciplinary teamwork. *(GC 10)*

Table 4. Competencies of chemistry student trainee teacher required for the implementation of selected methods of experimental learning.

(e) The use of the method of experimental work: *Generic competencies (GC), Chemistry subject competence (shortly CC)*
Interpretation and integration of experimental data with the theory, and vice versa
(1) Connecting macroscopic perceptions with interpretation on submicroscopic level and with records on a symbolic level. (CC 7) (2) Developing visualization skills of pupils for the presentation and understanding of the substance. *(CC 12)*
Safe experimentation and mastery of the basic measurement methods
(1) Ability to organize and conduct experimental work. *(GC 11)* (2) Knowledge of safe experimentation. *(GC 14, CC 6)* (3) The assessment of the use of chemicals and knowledge of safe handling of substances. *(GC 14, CC 6, 8)*
Mathematical competence
(1) Proficiency in mathematical problem-solving skills and developing them in pupils / students, evaluation of estimates of the order of units and the results. *(GC 7, CC 13)* (2) Evaluation, interpretation, integration of information and experimental data. *(GC 3, CC 3)*
Connecting science and society, knowledge of environmental issues
(1) Understanding of environmental issues and developing these awareness among pupils and students and search / intervention of measures to prevent and reduce pollution. *(GC 14; CC8)*

Table 5. Summary of competencies of chemistry student trainee teacher required for the implementation of evaluation work, experiential, cooperative and experimental learning.

Legend:

Frequency of competence is written with a number or dash (unexpressed): upper level (generic competences GC 1-14) and lower level (chemical competence 1-13) within each line.

Generic Competencies 1-14 Chemical Competencies 1-13	GC1 CC 1	GC 2 CC 2	GC 3 CC 3	GC 4 CC 4	GC 5 CC 5	GC 6 CC 6	GC 7 CC 7	GC 8 CC 8	GC 9 CC 9	GC 10 CC 10	GC 11 CC 11	GC 12 CC 12	GC 13 CC 13	GC 14
IMPLEMENTING ASSESSMENT WORK														
(a1) Using the evaluation folder	- -	- -	2 -	- -	2 -	1 -	- -	- -	3 -	- -	2 1	- -	- -	-

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

The introduction of an individualized approach to the process of teaching, learning and assessment	- -	- -	1 -	- -	2 -	1 -	- -	- -	2 -	- -	2 1	- -	- -	-
Encouraging evaluation, professional self-reflection and critical thinking	- -	- -	1 -	- -	- -	- -	- -	- -	1 -	- -	- -	- -	- -	-
(a2) Use of the oral examination	- -	- -	1 -	- -	- -	1 -	- -	- -	1 -	- -	- -	- -	1 -	-
Design of examination tasks	- -	- -	- -	- -	- -	1 -	- -	- -	1 -	- -	- -	- -	- -	-
Evaluation of results	- -	- -	1 -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1 -	-
Σ GCa1+a2 **Σ CCa1+a2**	- -	- -	3 -	- -	2 -	2 -	- -	- -	4 -	- -	2 1	- -	1 -	-
IMPLEMENTING AN EXPERIENTAL LEARNING														
(b1) The use of problem solving methods	1 2	3 -	2 -	1 -	5 -	1 -	- -	- -	2 1	3 1	1 -	2 -	3 -	-
The introduction of interdisciplinary integration of content and thus getting used to the approach of the overall problem solving	- -	- -	- -	- -	2 -	- -	- -	- -	- -	2 -	- -	- -	1 -	-
Introducing actualization of content	- -	- -	- -	- -	1 -	- -	- -	- -	- -	- -	- -	1 -	- -	-
Generic Competencies 1-14 Chemical Competencies 1-13	GC1 CC 1	GC 2 CC 2	GC 3 CC 3	GC 4 CC 4	GC 5 CC 5	GC 6 CC 6	GC 7 CC 7	GC 8 CC 8	GC 9 CC 9	GC 10 CC 10	GC 11 CC 11	GC 12 CC 12	GC 13 CC 13	GC 14
IMPLEMENTING AN EXPERIENTAL LEARNING														
Interpretation, integration and evaluation of information and data	- -	2 -	- -	- -	- -	- -	- -	- -	1 -	1 -	- -	- -	- -	- -
Understanding and solving quantitative and qualitative problems	- 2	1 -	2 -	1 -	1 -	- -	- -	- -	- -	- 1	- -	- -	- -	-

Checking the knowledge and performance of students and the design of feedback	1 -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1 -	2 -	-
Evaluation of solutions	- -	- -	- -	- -	1 -	- -	- -	- -	1 -	- -	- -	- -	- -	-
(b2) The use of learning methods with examples	1 -	- -	3 1	- -	- -	- -	1 -	- -	3 1	- -	- 1	2 -	1 -	-
Developing responsibility of pupils / students for their own lifelong learning	- -	- -	3 -	- -	- -	- -	- -	- -	1 -	- -	- -	- -	- -	-
Solving basic professional problems by finding sources of knowledge and application of scientific methods	1 -	- -	- -	- -	- -	- -	1 -	- -	2 -	- -	- -	- -	- -	-
Ability of oral and written communication and teamwork	- -	- -	- 1	- -	- -	- -	- -	- -	- -	- -	- -	2 -	1 -	-
Σ GCb1+b2 **Σ CCb1+b2**	2 2	3 -	5 1	1 -	5 -	1 -	1 -	- -	5 2	4 1	1 1	4 -	4 -	-
IMPLEMENTING COOPERATIVE LEARNING														
(c) The use of project work method Σ GCc Σ CCc	**-** **-**	**-** **-**	**-** **-**	**-** **-**	**1** **-**	**2** **-**	**-** **-**	**1** **-**	**-** **-**	**2** -	**3** **-**	**-** **-**	**4** **-**	**-**
Developing social skills of pupils / students	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	2 -	-
Introduction of pupils / students to active work	- -	- -	- -	- -	- -	- -	- -	- -	- -	1 -	1 -	- -	1 -	-
Enabling the differentiation of instruction	- -	- -	- -	- -	- -	1 -	- -	1 -	- -	- -	- -	- -	- -	-
Generic Competencies 1-14 Chemical Competencies 1-13	GC1 CC 1	GC 2 CC 2	GC 3 CC 3	GC 4 CC 4	GC 5 CC 5	GC 6 CC 6	GC 7 CC 7	GC 8 CC 8	GC 9 CC 9	GC 10 CC 10	GC 11 CC 11	GC 12 CC 12	GC 13 CC 13	GC 14

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

IMPLEMENTING EXPERIMENTAL WORK														
(d) The use of the method of experimental work **Σ GCd** **Σ CCd**	- -	- -	1 1	- -	- -	- 2	1 1	- 2	- -	- -	1 -	- 1	- 1	3
Interpretation and integration of experimental data with the theory, and vice versa	- -	- -	- -	- -	- -	- -	- 1	- -	- -	- -	- -	- 1	- -	-
Safe experimentation and mastery of the basic measurement methods	- -	- -	- -	- -	- -	- 2	- -	- 1	- -	- -	1 -	- -	- -	2
Mathematical competence	- -	- -	1 1	- -	- -	- -	1 -	- -	- -	- -	- -	- -	- 1	-
Connecting science and society, knowledge of environmental issues	- -	- -	- -	- -	- -	- -	- -	- 1	- -	- -	- -	- -	- -	1

Discussion

In the didactic and methodical analysis of the taught lessons at the time of continuous TP prospective chemistry trainee teachers did not develop competencies in the field of assessment and evaluation of pupils'/students' knowledge and feedback (Figure 1). From the repertoire of methods, suitable for the needs of teachers' assessment-evaluation work, a rational analysis of the competencies necessary for the effective use of assessment folders and oral examination was carried out. Almost half of the generic competencies (Table 1) are recognizably represented and have the highest frequency (table 5) of GC 9 (concern for quality) and GC 3 (Interpretation), with equal representation of the following competencies GC 5 (Learning and problem solving), GC 6 (Transferring theory into practice) and GC 13 (interpersonal interaction). The majority representation of competence »Concern for quality« convincingly confirms the validity of assessment and evaluation as essential components of the macrodidactic learning process.

Regarding the pedagogical nature of this activity non- identification of chemistry subject competencies is completely understandable, because the effective implementation of these requires priority mastery of didactic and psychological aspects of the learning process, but there is a compelling interest identified in CC 13, which complements the present convincing GC 5 competence.

Incompetency in the selection and implementation of new teaching approaches is also expressed in a high percentage in particular the methods and forms of work using project work, cooperative learning and multi-level instruction (Figure 3). Even competence-dissection of project work (as shown in Table 3) covers nearly half of the list of generic competencies, where GC 11 (organizing and planning of work) and GC 13 (interpersonal interaction) stand out. With the same frequency (Table 5) appear above mentioned GC 5,6 and GC 10 (independent and team work). For the same reason as above, even with this method chemistry subject competencies are not visible.

Within the didactic and methodological areas students often recognize the competence in the field of knowledge management and the methods and forms of work (especially contemporary) (Figure 2). A rational analysis of two innovative learning methods, namely problem solving and case learning points to a wide range of both generic as well as chemistry subject competencies presented in Table 2. When working with problem solving method it is possible to implement the entire list of generic competencies, only GC 14 (Provision of safety at work) is not explicitly defined. Of course the glaring competence of this method is represented by GC 5 (Learning and problem solving), while GC 2 (literature analysis and organization of information), GC 10 (Individual and team work) are more frequent. The frequency (Table 5) of competencies GC 3 (Interpretation), GC 9 (concern for quality), GC 12 (Verbal and written communication) and GC 13 (interpersonal interaction) should not remain ignored. These competencies cover all three areas of personal development - cognitive, conative, and psychomotor.

This method is more open to the realization of chemistry subject competencies, namely CC 5 (Interpretation of laboratory data observation and measurement of their importance and linking them with related theories), CC 7 (Proficiency in IT skills of online available information from primary and secondary data sources) and CC 10 (Demonstration (use of knowledge and understanding of the essential chemical facts, concepts, principles and theories in solving of (un)known qualitative and quantitative problems).

The method of learning with examples specifically demonstrates the more frequent realization of competencies GC 3 (Interpretation), GC 9 (concern for quality) and GC 12 (Verbal and written communication). However, two chemistry subject competencies, namely CC 4 (Evaluation, interpretation and synthesis of chemical information / data) and CC 7 (Proficiency in IT skills, including getting online available information from primary and secondary sources) can also be recognized (Table 5).

Despite the analytical tools which point to the implementation of target combinations of methods and forms of work with the support of learning resources, it is evident from the analysis of self-analyses that this competence remains unexpressed in half of the students (Figure 4). What priority is experiential learning in the field of chemistry education is represented by competence qualifications as shown in Table 4, where the most frequently (Table 5) occurring chemistry subject competencies are: CC 9 (acquaintance of safe handling of substances and carrying out laboratory procedures with the capability of assessing risk factors by using them) and CC 11 (Understanding environmental issues, assessment of risk factors using chemicals and implementation of laboratory procedures, as well as measures to prevent and reduce pollution). Of course there are also the following individually identifiable chemistry subject competencies: CC 2 (Linking macroscopic perceptions of explanation on a microscopic level and the records on a symbolic level), CC 3 (Knowledge of the structural properties of chemical elements and their compounds and stoichiometry), CC 4 (Evaluation, interpretation and chemical synthesis of information / data, CC 5 (Interpretation of laboratory data observation and measurement of their importance and integrating them with related theories), CC 6 (Proficiency in digital (including numerical, arithmetic) skills and error analysis and Internet communication for the purpose of operating the chemical information and data) and CC 13 (Planning, preparation and execution phases of applied research identifying problems through the acquisition and integration of information and data (from primary and secondary sources) to the evaluation of the results and conclusions using appropriate techniques and procedures work).

At a prime representation of chemistry subject competencies, the implementation of experimental work is associated with the implementation of selected generic competencies, with most frequented (Table 5) GC 14 (Ensuring Safety at Work), individually as well GC 1 (Collection of information), GC 3 (Interpretation), GC 7 (Using mathematical ideas and techniques) and GC 11 (Organizing and planning work).

Conclusions

Incompetency in didactic-methodical field expressed in: assessment, grading, selection and implementation of new teaching approaches (methods and forms of work using project work, cooperative learning and multi-level instruction), assessment and evaluation of knowledge established from prospective chemistry trainee teachers' self-analyses can be reduced by consistently using active methods of teaching and learning.

From the results of rational analysis of competencies acquired by using selected teaching methods (which was conducted by the authors), it is evident that the proposed methods cover a full range of generic competencies to a greater or lesser extent, individually also some chemistry subject competencies. Therefore, implementing a training program of prospective chemistry trainee teachers should be based on a consistent application of the proposed methods of teaching and learning.

It is well known that trainee teachers have a level of modelling competence (generic and chemistry subject–specific) that is lower than needed; therefore, the suggestions about modelling competences (Lopez, Costa, 2007) could certainly be applied with some modification to the use of contemporary teaching and learning methods. The implementation of continuous TP provides an opportunity for both the acquisition and development of these competences: these are essential for using, understanding, and learning in a science such as Chemistry (for learners) and for active implementation according to teachers' needs (for trainee Chemistry teachers). It is obvious that contemporary methods must be present in the everyday teaching practice of trainee Chemistry. Undeniably, the methods that they use have a significant impact on learning style and, consequently,on the development of more diverse competences in their pupils.

References

Australian Education Coucil (1991). *Young people's participation in post-compulsory education and training*, Report of the Australian Education Council Review Committee. Retrieved 13/10/2009, from http://www.dest.gov.au/sectors/training_skills/.

Cvetek, S. (2002). Pedago ka praksa in njen pomen za izobraževanje učiteljev. *Pedagoška obzorja, 3-4,*125-139.

Gevorgianienė, V. Kondrašovienė, L., Lazutka, R., Naujanienė, R., Švedaitė, B. , Zabulytė, Kupriūnienė, J., Žalimienė, L. (2012). *Guidelines of competence development in the study field of social work*. Retrieved 12/02/2013, from http://www4066.vu.lt/Files/File/11_Social%20work_guidelines.pdf

Halasz, G., Michel, A. (2011). Key Competences in Europe: Interpretation, Policy Formulation and Implementation. *European Journal of Education*, *46*, (3), 289-306. Retrieved from http://europa.eu/legislation_summaries/education_training_youth/lifelong_learning/c11 090_en.htm

Juriševič Juriševič, M., Lipec-Stopar, M., Magajna, Z., Krajnčan, M. (2007). *Praktično pedagoško usposabljanje: izhodišča-model-izkušnje*. Model praktičnega usposabljanja: od zasnove k izvedbi. Retrieved 13/8/2010, from http://www2.pef.uni-lj.si/model1/Porocila/PEF_Monografija.PDF

Key Competences for Lifelong Learning (2006). Retrieved 13/10/2009, from http://europa.eu/legislation_summaries/education_training_youth/lifelong_learning/c11090_en.htm

Lemut, M. (mentor Sikosek, D.) (2013). *Vloga in pomen strnjene pedagoške prakse kot oblike praktičnega usposabljanja učiteljev kemije v bolonjskih programih*. Diplomsko delo, Maribor: Univerza v Mariboru,Fakulteta za naravoslovje in matematiko.

Lopes, J. B., Costa, N. (2007). The Evaluation of Modelling Competences: Difficulties and potentials for the learning of the sciences. *International Journal of Science Education*, *29*, (7), 811-851.

Peklaj, C. (2006). Definiranje učiteljskih kompetenc: začetni korak za prenovo pedagoškega študija. V: *Teorija in praksa v izobraževanju učiteljev*. Ljubljana: Center za pedagoško izobraževanje Filozofske fakultete.

Polutnik, M. (mentor Sikosek, D.) (2005). *Kompetence (usposobljenosti) in oblike praktičnega usposabljanja študentov-učiteljev kemije: Analizni instrumentarij*. Diplomsko delo, Maribor: Univerza v Mariboru, Pedagoška fakulteta.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 53, 2013

Razdevšek Pučko, C. (2004). Kakšnega učitelja potrebuje (pričakuje) današnja (in jutrišnja) šola? *Sodobna pedagogika*, *55* (*posebna številka*), 52–74.

Razdevsek Pucko, C., Rugelj, J. (2006). Kompetence v izobraževanju učiteljev. *Vzgoja in izobraževanje, 37,* 34-41.

Sikošek, D., Žarić, K. (2009). How To Shape Master Chemistry Teacher By Bologna Guidelines As A Product Of Double - Major Study Programme - Educational Chemistry 2nd Degree, Presented at *"19th International Conference On Chemistry Education - Research, Theory And Practice On Chemistry Didactics"*, from 15/09 until 17/09/2009 in Hradec Králové, Chech Republic.

Sim, C. (2006). Preparing for professional experiences—incorporating pre-service teachers as 'communities of practice'. *Teaching and Teacher Education, 22,* 77–83.

Žaric, K., Sikošek, D., Golob, N. (2009). Kompetence specifične za kemijske vsebine v šolski vertikali. V: N. Golob, D. Sikošek, K. Žarić, E. Ferk (Eds.) *Kompetence specifične za kemijske vsebine po šolski vertikali*: S1.05: projekt: Razvoj naravoslovnih kompetenc: (Poročilo 1.4. 2009-30.6.2009). Maribor: Fakulteta za naravoslovje in matematiko, 8-10.

Québec Education Program, Cross-Curricular Competencies. Retrieved 12/02/2013, from http://www.mels.gouv.qc.ca/sections/programmeFormation/secondaire1/pdf/chapter3.pdf

Advised by Vincentas Lamanauskas, SMC "Scientia Educologica", Lithuania

Received: *January 30, 2013* Accepted: *March 23, 2013*

Darinka Sikošek	PhD., Assistant Professor of Chemistry Didactics, Faculty of Natural Sciences and Mathematics, University of Maribor, Koroška street 160, 2000 Maribor, Slovenia. E-mail: darinka.sikosek.@uni-mb.si
Kornelia Žarić	B.S., Teaching Assistant, Faculty of Natural Sciences and Mathematics, University of Maribor, Koroška street 160, 2000 Maribor, Slovenia. E-mail: kornelia.zaric@um.si

ISSN 1822-7864