SIE 2015
6th International Symposium on Industrial Engineering
24th-25th September 2015
FACULTY OF MECHANICAL ENGINEERING
STEINBEIS ADVANCED RISK TECHNOLOGIES
INNOVATION CENTER FME

CONTINUING PROFESSIONAL DEVELOPMENT FOR ENGINEERS - VOCATIONAL TEACHERS IN MECHATRONICS

Milica Gerasimovic[1], Tanja Sijakovic[2], Ugljesa Bugaric[3]
[1]PhD, Advisor/Coordinator, Institute for Improvement of Education, Belgrade
[2]PhD, Advisor/Coordinator, Institute for Improvement of Education, Belgrade
[3]PhD,Professor, Faculty for Mechanical Engineering, Belgrade University

Abstract. *This paper concerns the continuing professional development (CPD) of engineers - vocational teachers in mechatronics.Vocational teachers' work is based on teaching competence and competence related to a specific work-life vocational practice.Mechatronics is broadly based on three regions:mechanical, electrical and computer engineering,and represents a scientific field, which has been recently developing and growing in an unusually rapid way. Needs of mechanical and electrical engineers - VET teachers in mechatronics among the others areusing of new pedagogies andmaking extensive use of new technologies.In this paper, we analysevocational teachers' participationin Serbian Vocational Education and Training (VET) CPD program, in the field of Mechatronics in the sample of 43 VET teachers.The obtained results show thattraining topic of the greatest positive influenceand the greatest needs for CPD trainings are divided between new technologies in the workplace and various pedagogical and didactic knowledge and skills.*
Keywords: *continuing professional development, mechatronics, vocational teachers, engineers*

Vocational education

As the subject of studies and research, vocational educationis a significant phenomenon. The reason for continuing innovation and modernization of vocational education, among other things, is that the vocational education, based on labor market needs, keeps track of all changes of economic and technological development of society. The main objective of the reform of vocational education is to improve the quality of education, which involves the establishment: social partnership, decentralization, accessibility, openness, program and organizational diversity, and focus on outcomes.

The goals and circumstances of vocational education vary across countries. The specifics may vary from place to place, but in most countries academic education prepares students for college or university while vocational education prepares them for immediate entry into the labor market. The authors assume that vocational education equips students with skills which can enhance their productivity on the job, therefore, vocationally trained workers are in demand, and their chances of gaining employment are enhanced [1, 2, 8].

In the process of continual improvement and modernization of vocational education very important partare the teachers.

Vocational teachers' work is based on two main competences: teaching competence and competence related to a specific work-life vocational practice. Teachers in vocational education need to complete a pedagogical education in their first years of teaching in addition to teaching.

Vocational teachers are expected to be well qualified, knowledgeable and up-to-date in the vocation they teach. Changes in working life and the modernizationof vocational education place new demands on vocational teachers' competence [7].One way for vocational teachers to maintain a high-quality professional identity is to continue to have contact with their vocational field.

The aim of this article is to explore vocational teachers' participation in Serbian Vocational Education and Training (VET) Continuing Professional Development (CPD) program, specifically in the field of Mechatronics.

Mechatronics

There are many different ways of defining the meaning of mechatronics.Some authors defineme chatronics as a synergistic combination of mechanicalengineering, electronics, computer science and control engineering [11, 3],and the most common definition of mechatronics is "synergistic combination of mechanical engineering, electronic engineering and software engineering" [5]. Mechatronics relates to the design of systems, devices and products aimed at achieving an optimal balance between basic mechanical structure and its overall control.

Mechatronic curriculum in Serbia

In Serbian VET system mechatronics as aneducational profile Technician of Mechatronics is available in 20 VET schools. The curriculum developed on the basis ofqualification standards. The purpose of Technician of Mechatronics qualification is[4]:

- repairing and maintening equipment and mechatronic devices and system,
- installing of machatronic components,
- diagnosing faults.

Curriculum consists of general and vocational subjects. The main vocational subjects and moduls are:

- Digital electronics and microcontrollers;
- Hydraulic and Pneumatic;
- Electric drive and equipment;
- Modeling withanalysisof the elements and mechanisms;
- Programmable logic controllers;
- Testingand diagnosticsofmechatronic systems.

An important part of the curriculum are the subjects which supporting learning process and development of professional competencies. Some of them are:

- Mathematics;
- Technical drawing;
- Physics;
- Technicalmechanicswith mechanisms;
- Machine elements;
- Electrical engineering (basic level).

Mechatronics curriculum comprises a range of subjects that arefundamentally different in nature and which require very different learning andapplication practices.The essence ofa well-developedMechatronics curriculumreflected on the physics-based relationship between mechanical and electrical systems.

VET teachers in Mechatronics

Mechatronics is broadly based on three regions:mechanical, electrical and computer engineering.In this moment there are about 80 teachers in Mechatronics in Serbia and they are mechanical and electrical engineers. The complexity of their work is reflected in the developmentboth practical and theoretical student's understanding of mechatronics as well as interpersonal and communication skills needed to work in a multi-disciplinary field. Tasks and problem solving in mechatronics requires cognitive and operational knowledge and practical experience about building systems, diagnosis and maintenance-techniques.

On the other handmechatronics represents a scientific field, which has been recently developing and growing in an unusually rapid way.

Therefore, needs of mechanical and electrical engineers - VET teachers in mechatronics are: using of new pedagogies, teaching new competences, working more closely with their colleagues and employers and making extensive use of new technologies.

Continuing professional development

It is well known that continuing professional development of teachers is important part of improving the quality of education. In other words, without the continuing professional development one cannot expect quality teaching and learning in schools. Overall context in which education takes place are significantly changed in the last few decades. Consequently, competences expected of teachers have become an integral part of the global, but also national governing educational policy. These competences are supposed to be developing during the initial teachers education as well as during the in service teacher training.In Serbia, the concept of professional development of teachers is given in Law on the Basis of Education System and Rulebook on permanent professional development. According to the above document each teacher is required to have 120 hours of Professional training for a period of five years. These 120 hours include attending seminars (at least 100 hours of training) and, up to 20 hours of other forms of training such as conferences, round tables, etc. In order to be evaluated in the context of professional development, seminars must be officially approved. Approval of the seminar is carried out in the Institute for Improvement of education. Accredited Commission approved courses in every two years, according to nationally set priorities and defined competencies of teachers.The number of points that seminar brings to participant is directly related to the total number of hours of training. Also, the round tables, conferences etc., must be approved at the Institute for Improvement of education, in order to bring points to the participants.Once approved, these types of professional training bring one point to participants, for every completed day.

One of the frequently asked questions of experts is the efficiency and significance of training based teacher professional development. In other words, in orderto be effective professional development should rely on the fulfillment of the basic principles

of meaningful development.In that sense, Littlestates six principles for meaningful professional development [6]:

1. Professional development offers meaningful intellectual, social, and emotional engagement with ideas, with materials, and with colleagues both in and out of teaching
2. Professional development takes explicit account of the contexts of teaching and the experience of teachers
3. Professional development offers support for informed dissent
4. Professional development places classroom practice in the larger contexts of school practice and the educational careers of children
5. Professional development prepares teachers (as well as students and their parents) to employ the techniques and perspectives of inquiry
6. The governance of professional development ensures bureaucratic restraint and a balance between the interests of individuals and the interests of institutions [6].

Inspired by some of these principles, we have done research with VET teachers in Mehatronics, that will be presented below.

Research

In order to evaluate functionality of previous trainings and needs for further improvement of teacher competencies survey was conducted on a sample of 43 VET teachers in mechatronics from 14 Serbian's VET schools.A questionnaire has been created on the basis ofTALIS(The OECD Teaching and Learning International Surveyquestionnaire), adapted for VET teacher's needs. There were 12 questionsrelated to general information, practical application of in-service training, the need for further training and restrictions. Survey was conductedonlinein the spring 2015.

The statistical analysis is performed using the SPSS 18.0 software [8].

Results and Discussion

The findings particularly focus on the variablesofage, impact of CPD in teaching process, needs for CPD and obstacles to professional training.

In 58,1% of the cases of participation, the participant was male, and in 41,9% of the cases, the participant was female. The variable of years in teaching process was categorised into the sixgroups, and the distribution of participants is shown in Table 1.

Table1 Years in teaching process

1-2 years	3–5 years	6–10 years	11–15 years	16–20 years	≥20 years
4,7%	7,0%	18,6%	32,6%	14,0%	23,3%

The next aspect that was examined in the analysis was the functionality of previous CPD trainings. Training topics of great positive influence in teaching process in mechatronics were: implementation of the curriculum based on outcomes and competences (30,2%); monitoring and evaluation of student achievement(25,6%); IT (25,6%); new technologies in the workplace (34,9%);application of different methods, forms and techniques in teaching process (34,9%); encouraging critical thinking (32,6%); teamwork and school cooperation (41,9%) and explore own teaching practice (34,9%).

The findings showed that the great need for CPD trainings in mechatronics were in the following areas:

newtechnologies in the workplace (25,6%); motivationstudentsto learn(18,6%);teaching students with special needs (11,6%)and explore own teaching practice (11,6%).

It is interesting to see what participantsmentioned as a restrictions for their professional development in mechatronics (Table 2).

Table2 Restrictions for CPD

Restrictions	Frequency (%)
CPD training is too expensive / unavailable	74,4
Lack of school management support	18,6
Lack of time	16,3
Lack of appropriate CPD training	74,4
Lack of motivation	11,6
The decision of CPD training is made at the school level (inability of choosing)	37,2

In summary the findings showed thatthere were slightly more male participants than female and the participation mostly rate among the 11-15 years of teaching experiences (32,6%).Training topic of the greatest positive influence in teaching process were team work and school cooperation, application of different methods, forms and techniques in teaching process and new technologies in the workplace. The greatest need for CPD trainings are divided between new technologies in the workplace and various pedagogical and didactic knowledge and skills.

Conclusons

Professional development is a complex process that involves continuous development of teachers' competences in order to improve their performance and consequently student's achievement.This means that it has to rely on the knowledge and skills that teachers already have, that it has to take into account their previous experience and to respond to theircurrent needs. Following this line, a significant number of surveyed teachers claimed that they need additional knowledge in new technologies in the workplace, but also in the field of pedagogical and didactic knowledge and skills. According to the fact

that in Serbia there is still no education for the teaching profession in secondary vocational education, the need for additional knowledge in pedagogy and didactics is not surprising. This could be one of the key obstacles to the quality of our educational system. It becomes more than obvious that we cannot educate engineers to be teachers during the in-service trainings, but we need to shape them for teachers during the initial education.

As we saw from the results VET mehatronics teachers mostly claim that there is a lack of appropriate CPD training for them, that those trainings which exist are too expensive and that teacher do not have many opportunities to choose trainings but it is done on school level.

All this leads to the conclusion that the current system of CPD mechatronics teachers, insufficiently respect their needs and opportunities. There is no balance between the interests of individuals and the interests of institutions which supposed to be one of the main principles for a meaningful professional improvement.Those who create trainingsfor teachers can't do this with neglecting the teacher's needs, previous knowledge, experience and motivation for the training[10].This is part of CPD that needs to be improved in furtherer period.

Literature

[1] Bishop, J., (1989). Occupational training in high schools: when does it pay off? *Economics of Education Review,* 8, 1-15.

[2] Blossfeld, H.P., (1992). Is the German dual system a model for a modern vocational training system? A cross-national comparison of how different systems of vocational training deal with the changing occupational structure. *International Journal of Comparative Sociology*, 23, 168-181.

[3] Brown, N.J., Brown O.T., (2002). Mechatronics – a graduate perspective. *Mechatronics*, 12, 159–167.

[4] Gerasimovic, M., Mitrovic, G., (2015). Tehnicar mehatonike nastavni plan i program u strucnom obrazovanju zasnovan na standardu kvalifikacije. *Mehatronika strucni casopiszasavremeneinzenjere*, 2, 36-37.

[5] http://tryengineering.org/ask-expert/what-difference-between-robotics-and-mechatronics-also-how-does-mechanical-and-automation

[6] Little, J., W. *Teachers' Professional Development in a Climate of Educational Reform*. In: Anson, R.,J., Systemic Reform. Perspectives on Personalizing education, 1994, 105-137.

[7] Parsons, D., Huges, J., Allincon, C., Walsh, K. *The training and development of VET teachers and trainers in Europe*. In: Cedefop (ed) Modernising vocational education and training, fourth report on vocational education and training research in Europe: synthesis report. Publications Office of the European Union, Luxembourg, 2009.

[8] Rumberger, R., Daymont, T. *The economic value of academic and vocational training acquired in high school*. Chapter 6 in M. E.Borus (ed.), Youth and the Labor Market: Analysis of the National Longitudinal Survey, Kalamazoo, MI: W. E. Upjohn Institute for Employment Research,1984.

[9] SPSS 18.0 http://en.softonic.com/s/spss-18-download Accessed 20 January 2011.

[10] Sijakovic, T.*Upravljanje profesionalnim usavrsavanjem: iskustva iz Srbije.* U: Van Balkom, D., Mijatovic, S., Strucno usavrsavanje – iskustva edukatora za edukatore. EDP, 2006.

[11] Tan, KK., Lee TH., Dou HF., Lim SY., (1998). Various developments in mechatronics in Asia. *Mechatronics*, 8, 777–791.