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KEY COMPETENCES FORMATION AND EFFECTIVE SUPPORT OF STUDENTS MOBILITY AT TECHNOLOGY FACULTIES: MODELING, DESIGN AND ASSESSMENT OF FLEXIBLE EDUCATION CONCEPT

The paper brings the results of the current national educational agency project research of effectiveness of the modular didactic cycle with new technologies, methods and forms in student-focused concept through the processing of experimental data of the electronics study program from the period of 2016-2017. Data were collected from contributions kept by the students groups during the preparation phase and also from reflective final phase of the research period. Also, the presented solution and results of the project are directed at the main component of the educational process – the content of education and its compatibility with the technological trends in the actual working environment. The results show that digitization of the learning content and flexibility of design of educational modules with multimedia components are dominant and indicate compatibility with the trends of flexible educational environment. In addition, the results of project illustrates that even the change can be difficult, success can be attained in the most heterogeneous diversification of university education and mobility of graduates of technical universities that will contribute to increase of educational efficiency and will encourage arrival of investments to innovative entrepreneur projects and, mainly, will help national firms to succeed at EU and world market by strengthening of the dominant subject which produces values – the technical field graduate with the key competences for the 21st century needs.

KEYWORDS: key competences, flexibility, mobility, higher education didactics.

1. INTRODUCTION

1.1. Key competences of graduates

The effective flexible educational environment for technological education at technical faculties examines the obstacles concentrated on the support of devel-

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opment of key competences of graduates of technical faculties by means of massive technological support directed at synergy of components of knowledge base and its integration with competences of graduates of technical study fields in an actual working environment. The main aims are related to the setting up educational environment, the integration of the content of education and the support of effective transfer of knowledge into the actual environment of the European working market challenges.

1.2. Flexible educational environment characteristics

We are convinced, based on over 30 years of experience and activities in leadership, research, education and transfer of knowledge into innovation, that all the components of effort - personal, educational, management, and financial in the formation of useful target cognitive activities are ineffectively deployed as a primary resource and therefore a major area of interest student operations [1]. The project is aimed at addressing the effectiveness of higher education. The current phenomenon of higher education is the most communicated topic of the low level of high school graduates in Slovakia compared to graduates of universities in the world. In the context of focusing the project, we focus on technical faculties of higher education institutions, with the comparison of the key competences of the graduate. The objectives of our works are focused on new methods, forms and educational technologies and synergies in terms of digital content education and modular multimedia tools [2]. The project is horizontally formed from two main and several secondary areas. The first major area is the sophisticated technology used in an innovative production environment. The second area focuses on exploring effective educational teachings, concentrating on the synergy of both main areas. The vertical structure of the project is based on the application of effective educational forms, methods and principles with the concentration of the optimal model of the didactic cycle on the development of key competences in the modular education concept, based on the formation of selected content.

1.3. Education modular environment structure

In a modular conception of education based on the formation of selected learning modules in the field of electronics, mechatronics and autotronics the modules, also by confronting the needs of the production environment and the educational tools for the formation of the targeted students of the faculty of electrical engineering with awaited flexibility and mobility. The dominant position in the formation of the working environment needs not only the presentation, but also the verification and evaluation of the selected educational model has participants from specific areas (national, international). The project focused on the research of the efficiency of the didactic cycle with the new technologies, methods and forms in the teaching [3].

2.1. Research goals, methodology, objectives, procedure

The main goal of the project work is in conceptual modelling, design, creation, validation and introduction of open learning modules to support the development of key competences of students in the field of technical sciences to promote flexibility and mobility. The objectives of the project are formulated in the context of effective use of new technologies, methods and forms in education and address the area of content integration and diversification of higher education [4]. The objectives of the project are fulfilled in the individual sub-areas that are part of the project's structure.

Objectives: To obtain, process and analyse data from the educational environment to monitor students' activities and correlation with learning outcomes in comparison to employers' multiple preferences.
Partial goal: Hierarchy of preferences matching
Phase: Reflection to flexible education and project concept
Activity: Assessment of individual respondents ´preference benefit
Importance (left column – employers) and weight of preferences (right column): 1 - very important, 2 - partly significant, 3 - cannot judge, 4 - less significant, 5 - completely insignificant (Tab. 1).

2.3. Learning styles monitoring

As effective and innovative educational environment, one of research goal is to provide the best possible educational environment. In order to evaluate the correlation of students learning styles and teachers teaching styles for comparisons between data file on with primary focus on differences and determination of dominant styles we adapted Felder-Silverman theory in designing of questionnaire specified for students to discover students learning styles [5]. This work shows the basis of preparing concept for new learning content, which leads to experimental modules for specific subjects and aims at specific group of students studying on engineering faculty. At the same time, this concept respects student´s learning styles for pedagogical experiment in order to verify efficiency of the suggested methodology. For purposes of this study we prepared specific questionnaires for students consisted of 44 antagonistic questions for antagonistic learning styles. In Tab. 2 are twinning of 11 questions coupled to 4 investigated learning styles. Content of questionnaire is designed as a typical narrative story and twins of questions for antagonistic learning styles are adapted with respect to the world in which today's people live; interpretation to educational sphere impact is in Tab. 3., correlations to learning and teaching activities are in Tab. 4.

Table 1. Results of the students competences multiple preferences in 11 experimental groups.

Multiple preference	**Number of respondents 106**				
	Preference weight (students)				
Preference characteristics (employers)	**1**	**2**	**3**	**4**	**5**
1 - acquisition of new information	44	48	7	5	2
2 - general insight on issues	27	53	17	7	2
3 - master the methods to support creativity	15	46	33	9	3
4 - support skills in computer programmes	11	26	35	26	8
5 - generate new ideas	14	36	38	14	4
6 - improve competences expression	21	37	32	14	2
7 - gaining insight in a given area	46	41	13	4	2
8 - implementation of the knowledge to practice	27	33	31	12	3
9 - ability to make a decision to the proper selection	14	35	44	11	2
10 - ability to take the presentation of the results	15	35	36	17	3
Total	**234**	**390**	**286**	**119**	**31**

Table 2. Antagonistic learning styles characteristics.

Antagonistic learning styles with abbreviation	Characteristics
ACTIVE - ACT	engagement in educational activities and discussions
REFLECTIVE - REF	introspection, contemplation, speculation, philosophical
SENSITIVE - SEN	sights, sounds, physical sensations
INTUITIVE - INT	invention, imagination, possibilities, intuition
VISUAL - VIS	appearance, visual aspects, pictures, demonstrations
VERBAL - VER	word description, sounds, story, narration, poem
SEQUENTIAL - SEQ	continual steps
GLOBAL - GLO	holistic, large jumps, planar, area, surface

Table 3. Antagonistic learning styles and sphere of impact.

Antagonistic learning styles	Educational sphere of impact
ACT – REF	Processing of information
SEN – INT	Type of information/instruction preferentially perceived
VIS – VER	Kind of sensory channel for external stimulus perceived
SEQ – GLO	Understanding of information procedure

Table 4. Antagonistic learning styles in correlation to learning activity and teaching activity.

Antagonistic learning styles	Students appropriate learning activity	Teacher appropriate teaching activity
ACT - REF	Processing	Student engagement
SEN - INT	Perception	Content
VIS - VER	Input	Presentation
SEQ - GLO	Understanding	Perspective

The findings are summarized in a series of tabular reports in aggregate numbers of relative units (%). As an example, following results of experimental group EG9 it is possible to see dominant learning styles in antagonistic domains (Tab. 5). Dominant learning style balance is highlighted in 3 different colours: red – extremely unbalanced, yellow – unbalanced, green – well balanced. In order to create optimal learning environment, it is important to understand differences in students´ learning styles. Individual students preferentially focus on different category of information and tend to operate on perceived information on different ways, and transform to different level knowledge [6]. Acknowledging that students in a class have different learning styles give the teacher to apply a variety of educational strategies – teaching methods, didactical forms, techniques, educational technology, didactical rules, experimental tools, etc. to engage students off all learning styles. All of students than has opportunity to use individual learning style and improve the less-preferred learning style depending on specific learning content and key competences required. We analyzed data using statistics that allowed investigation of a more complete picture of selected group of students using Pearson correlation coefficient for pre-tests and post-test data comparison for learning styles as the independent variables estimated an importance.

Table 5. Individual learning styles – selected sample EG9.

No.	1	2	3	4	5	6	7	8	9	10	11	SUM	%
ACT	5	5	9	10	9	7	6	7	8	6	9	81	66.9
REF	6	6	2	1	2	4	5	4	3	5	2	40	33.1
SEN	8	9	4	9	7	5	10	6	8	4	8	78	64.5
INT	3	2	7	2	4	6	1	5	3	7	3	43	35.5
VIS	5	8	9	9	11	10	9	9	11	10	9	100	82.6
VER	6	3	2	2	0	1	2	2	0	1	2	21	17.4
SEQ	5	6	7	6	10	3	6	4	7	5	3	62	52.2
GLO	6	5	4	5	1	8	5	7	4	6	8	59	48.8

3. DESIGN OF COMPETENCES FORMATION STRUCTURE

Students learn to perform real operations through learning content that aims to develop and achieve the student's core competencies. The student's competencies are thus focused on what the student has learned and can do and not just what the student is learning at school. Learning objectives are precisely formulated in the context of the beneficial properties of a university graduate and the results achieved are precisely measurable - they are the required knowledge, skills and behaviour of the students. Engineers not only need knowledge of the basics but also cognitive application-specific expertise [7]. The reality is that very few educational modules are doing "original blank sheet of paper" designs of new product sophisticated topologies. Instead, they are relying heavily on reproductive designs from standard referenced "catalogue cookbooks". We designed the ability to deal with targeted areas through the compatibility of real world area, content teachable moment, and learning key competences representative characteristics in modules, as shown in Tab. 6.

These tailored modular courses with key competencies formation structure give students easy access to the valuable learning techniques used by experts in science and technology, and other assets derived from pedagogic disciplines. The data of knowledge pre-test and post-test were analyzed quantitatively by reporting Pearson's correlation coefficient. The interpretation and use of Pearson's correlation coefficient varies based on the context and purpose of the study of didactic tests data calculation (selected preferred items).

Table 6. Key competences formation structure in module Electronics.

Real world area	**Content teachable moment**	**Learning key competences**
Power transmission, electric drives, motors, battery-powered vehicles, etc.	Power parameters: • high electrical parameters are critical, low voltage is the current trend, • components currents are low, board and system level currents of tens and hundreds of amps are often the standard.	Knowledge: • safety regulations and mandates, including maintenance and services are critical, • quantify losses (connectors, contacts, buses, microcomputer board, any elements carrying currents).
Mechanical and thermal products design procedure	Circuits design: • module is much more than the physical implementation of a schematic diagram, • hazard starters - control board components materials, dimensions, wiring insulation thickness, bonding technology as.	Skills: • proper mounting higher-power active and passive components (holes, clamps, and other restraints - • product may work on the lab bench but fail after some real-world stresses), • credible thermal model development and assessment heat sources for convention, and conduction, allocation and analysed, so that a design's total heat from sources to sinks).
Complex multi-rail operation (systems with multiple voltage rails)	Development of multiple sources: • via a single controller IC with multiple outputs, • fully independent supplies.	Experiences: • with addition to the obvious of nominal voltage, tolerance, regulation, • transient response required for each, proper power timing and sequencing defined and assured.

Modelling, simulation	Performances and losses: • both electrical and thermal - must be assessed in advance, • since changes to the layout usually becomes a ripple effect situation.	Skills in elements dynamic performance: • modelling to avoid oscillation or instability in the required transient performance. • simulation of parasitic effect.
Certification, compatibility, testing (EMC, EMI, RFI)	Interpretation: • which concept apply and how, • deciding how to meet optimal operation parameters, • methods of tests to the design certification.	Decision: • to be familiar with electronic loads, programmable to simulate the static and dynamic aspects of the load, • to galvanic isolated elements measuring key currents and voltages tested instrument's "ground" (the wrong point can defeat the isolation and even damage the product).
Assessment	Switching concept: • modules are more efficient than analogue linear ones, • in the targeted applications analogue linear modules may have comparable or even better efficiency (lower total cost and fewer issues), • digital supplies with firmware algorithms rather than complex analogue circuits may offer great benefits and flexibility.	Flexibility: • target to increasing demands on today's products for high performance and increased efficiency, • aimed to bring the right tools and attitude to both the overall design and the practical realization.

For statistical research data of 11 experimental groups of 106 respondents interpretation, the correlation coefficient based on the data set of entering knowledge didactic test competences items and the output knowledge didactical test pertained items, the correlation value is resulting value of $r_p = 0.9105$ indicates a very strong and positive linear relationship between examined variables. In presented study we compared of two variables that are not normally identified as related – entering data variable and output data variable.

4. CONCLUSIONS

The paper presents an innovative way in which higher education can help at effective flexible educational environment for education at technical faculties. The main purpose of our works brings benefits in concentration to the support of development of key competences of graduates of technical faculties by means of massive technological support directed in synergy of components of knowledge base and its integration with competences of graduates of technical fields in an actual working environment. The paper moves up the educational environment in the integration of the content of education and the support of effective transfer of knowledge into the actual market challenges. Furthermore, the research suggested to the conceptual solution of flexible education through the design and verification of the open educational modules in an essential contribution to support the development of key competences of students in the specific field of technical science. The study suggested that the modular learning strategies employed in the study were useful to open learning style insight in promoting the student creativity, activity, cooperation, and the critical thinking, as well.

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