TEACHING MATHEMATICS IN TECHNICAL COLLEGE: TRADITIONS AND INNOVATIONS

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Abstract

This article studies two levels of continuous education: primarily, for technical colleges providing "general secondary education" and further for the college-university integrated system, as related to mathematical disciplines. For research purposes we apply system analysis and competence-related approach, as we consider the education process to be focused on compulsory vocational streaming.
The study provides a brief analysis of definitions "professional competence", "vocational streaming" and "continuity in education". It involves more detailed analysis of the education contents being applied within the methods system.
The studies are mainly based on the leading engineering college in Belarus – Minsk State Higher Radio-Engineering College. Author proposes a complex of innovative reforms in the educational process to improve the education quality.
Key words: *continuous education, continuity, professional competence, vocational streaming.*

Introduction

The focus on targeted development of various educational institutions, functioning in the integrated system of basic, secondary vocational and higher education under the continuity principle, is currently an essential element of the Belarusian policy, the same being important for most other democratic countries. In this field, colleges are a rather new phenomenon, and, therefore, the education principles for this type of institutions have not been studied thoroughly as yet. It is coming even more important in case the traditional "knowledge-skills-practice" education model takes on special individual-oriented continuous feature, acquiring the major idea of "*life-long human development into the personality of active stand and relations*" (Tarantsey, 1995, p. 51).

Methods of Study

Nowadays, our traditional education, currently oriented on unified fundamental mathematical disciplines teaching to primary college students followed by vocational streaming at senior years, requires both theoretical and practical modernisation. There are different innovative approaches to education problem study. Here we apply the so-called ***competence-related*** approach, incorporating the following principles, in particular: mathematical background shall be trained and practiced at all levels of mathematics teaching and, concurrently, the students' professional competence shall be developed. Thus, following the view of the system analysis being indispensable for education research, we can define the problem as follows: a system of mathematical disciplines teaching methods for technical college students shall be created un-

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der the continuous education principle and in the context of professional competence development.

Education continuity

All levels of the continuous education can efficiently interact only if the basic didactic principle – ***continuity*** of education – is strictly followed. For our research purposes, we deal primarily with the "general secondary education institution / college" level and further with the college-university integrated system. The continuity principle should be analyzed in details due to its importance and wide application.

In methodology, continuity is a universal principle being a major demonstration of the negation-of-negation theory. If applied for education, this theory has a special manifestation with the positive base retention and further development being predominant and decisive. The philosophic interpretation of continuity serves the methodological background for continuous education system organisation. The continuity in education provides for the education system's integrity and is generally construed by most researchers as a proper interrelation between different sections of disciplines being taught at different levels. At the same time, there are two main continuity forms defined: same-level continuity (providing quantity development) and several-levels continuity (providing quality development).

When dealing with continuous education, the "continuity" category is essentially enriched to the extent that wide-scale education subsystems are interrelated as integral parts of the country's continuous education system. Each level of education can be characterised with its specific development features to provide optimal prerequisites for education quality level upgrade by students' targeted development streaming.

Thus, after A. P. Smantser (1995), education continuity is considered a regular, systematic, step-by-step and interrelated development streaming in the students' education progress, involving targeted modifications in each level of development. Well-organised education implies continuous and targeted streaming in development and operates most intensively in neighbouring development levels. For most efficient and harmonic functioning, the continuity-related didactic system of education requires absolute realisation of its elements at each level of the education process.

Having analised education science writings, we could reasonably verify the education continuity problem within the school-college and/or college-university levels to be poorly studied. This is possibly reasoned by specific character of each educational institution and diversity of the disciplines being taught.

Professional competence

As given above, we shall study the education process being necessarily focused on vocational streaming. For this purpose we should briefly define the terms "professional competence" and "vocational streaming" and determine the interrelation between them.

Firstly, let's specify the definition "***professional competence***". After A. Petrov (2004), this means "*qualified high-level practicing of vocational background; ability to independently build up further vocational development; professional communication ability; professional responsibility for personal performance*" (p. 10). Other researchers have the similar view on this issue while suggesting different classifications for professional competence. For example, referenced by a wide-range comparative analysis of education science writings, O. L. Zhuk (2004) differentiates two main variants of competence in professional sphere: special and key competence (p. 45). Further, the author provides the following groups of higher education graduate's competence: social, vocational, communicative, informational and educational competence (p.47).

When analising the terms "competence" and "proficiency", we can make the following conclusion: modern scientific literature imparts some wider meaning to such definitions, as compared to "knowledge" / "skills" / "practice", as they employ some personal characteristics (purpose orientation, independent thinking, flexibility, will, etc.).

Vocational streaming

Many researchers argue that the major precondition for student's personality advanced development is the education ***streaming***, inasmuch as this adds positive emotional colouring to any profession and benefits to better learning and acquiring proper skills and experience. The education psychology writings represent this definition from various angles: some scientists understand streaming as a leading structure, system of motivations (Rubinstein, 1976), some of them – as an individual relation to the community, other individuals, self-representation (Yakobson, 1969), others define the same as psychic features determining general human activity direction in different situations (Levitov, 1969).

As far as the notion "***vocational streaming***" is concerned, most authors consider it to be an element of the overall individual orientation, which includes structurally and conceptually the formation of "plans for life", "professional intentions", "readiness to choose profession". The concept was developed by N. M. Noskov and V. A. Sheshnyova (2005): "*Vocational streaming in teaching mathematics involves such academic appliances and textbooks and such forms and ways of learning that would conform to the logical and systematic mathematics course training in its integrity and simulate (imitate) cognitive and practical problems of the future specialist's professional practice*" (p. 62). Although the above study relates to higher institutions, the same can be apparently applied to the secondary vocational education as well.

Teaching and organisational methods of individual vocational streaming are closely connected to discipline selection criterion. In our opinion, vocational streaming in teaching this or that discipline is one of the didactic principles, which would reflect the application and practical orientation in teaching, i.e. adaptation of education contents and methods to interrelated teaching any discipline with other disciplines, to apply the attained theoretical background in further professional activity. For the purposes of each student vocational training being oriented on future specialist's professional competence development, a well-grounded system of education / training objectives shall be properly built up, which would definitely benefit in general to the education process practicability and vocational streaming proficiency. When applying corrections to education objectives and content modernisation, the methods system integrity should never be avoided and neglected. After G. I. Sarantsev (2005), such system includes objectives, contents, means and forms of mathematics teaching, as well as external influencing factors, "individual structure and laws of individual development" (p. 31) being of importance among them.

Innovations in teaching mathematics in technical college as the study outcome

Our studies are mainly based on Minsk State Higher Radio-Engineering College (MSHREC) with its specific two-level education system – the level of secondary vocational training (first level) and the level of higher education (second level). The aforesaid college is the leading engineering college in Belarus, and that is why the studies within this establishment may serve a generalised example for other similar educational establishments. Upon successful completion of the secondary vocational education with MSHREC, the graduates are entitled to follow continuously their education to the higher level with such higher education institutions like the Belarusian State University of Informatics and Radio-electronics or the Belarusian National Technical University (starting from the 2nd or 3rd academic year, depending on specialty (major)). In this connection we face the problem of adapting the college education up to the university education standards.

Teaching mathematical disciplines in college is organised as follows. Students having basic secondary education are given an integrated course of mathematics and higher mathematics, aimed at theoretical thinking formation and higher mathematics initialisation. During the following years the students study higher mathematics followed by the theory of probability and mathematical statistics at the late 3rd year, and additionally applied mathematics and/or methods of economic & mathematical simulation (depending on their future profession). Starting from last year, a new discipline – experimental data control & processing – was introduced at the 4th year of the higher education level, which is aimed at wide-range mathematical theory

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application in future professional practice.

Let's analyse the main directions of MSHREC education & training process in the context of education continuity. Firstly, the college education organisational principles correspond to those with the higher institutions (theoretical, practical, combined and testing studies) and differ to a certain extent to that practiced in general secondary education schools. Specifically, at the initial level of mathematics teaching a combined form of studies is applied to be well accommodated to first-year students, and then a gradual differentiation into theoretical and practical training courses is made followed by investigation elements integration afterwards. Secondly, the education process structure includes all procedural components, specific to both secondary and higher institutions (education, training, scientific research activities). Thirdly, the teaching methods, means and technologies being applied correspond to those in higher institutions. In addition, the education employs vocational streaming and meets the following requirements: to train competent and qualified professionals; to diversify methods and ways for vocational streaming realisation; to establish inter-discipline relations in each disciple teaching; to coordinate and combine secondary and vocational education. And, finally, some specialised disciplines are taught under the same academic programmes as practiced in universities, such programmes being a connecting link between the general education programmes, curriculum and subject-oriented schedules (calendar plans).

Thus, continuity in college education represents a process providing college students' regular and step-by-step development, which is expressed in education problems gradual complication for the purposes of education upgrading to finally obtain the higher vocational education.

Conclusions

In our point of view, theoretical investigations should be turned to their practical realisation. Thus, to get a better quality of education, we are implementing a range of innovations: mathematics education content correction; new curriculums and programmes elaboration; creation of a new system of applied problems; optimal methods and means selection; cognitive process activation and students' scientific research activities encouragement, etc. At present, we carry out experiments in implementing the new teaching methods system, worked out in theory, to solve the above problem.

The dominant element of any methodical system is the contents of education, which is defined, after B. S. Gershunskiy (1980), as "the scientific information, well-grounded under education principles, logically systematised and made in writing, to be provided for learning purposes" (p. 9-10). Having analysed the major logical relations of mathematics and other disciplines, we found the education content elements to be organically inserted in other vocational disciplines. Then, taking into account the rational correspondence of fundamental and vocational background, skills and experience, we classified the selected education materials due to its importance, continuity and teaching level criteria. Never neglecting the education procedure, corrections to education methods and forms were made for students' motivation purposes. Further on, we faced the problem of mathematics teaching stimulation in computer-aided surroundings and further professional competence formation. At present, the problem is under way to be successfully solved. Thus, for example, computer testing is widely used for higher mathematics digestion control; special applied software is generally practiced for labs and practical training in the theory of probability and mathematical statistics; applied mathematics is lately and efficiently lectured as computer-aided presentations, etc. Modernised to accommodate the technical / engineering university standards, the college mathematics teaching process is more focused on vocational streaming and permanent specialty-related professionalisation and incorporates mathematics special courses of lectures, as may be specifically required for specialty disciplines. The traditional studies innovationally provide more time for students' independent work, which is critically important for information technologies incorporation in the education process, thus ensuring switch-on from teaching to learning and following student's self-realisation.

If and when implemented, the suggested innovations, in our opinion, would benefit to students' more positive motivation in acquiring mathematical background, self-education in-

crease and, finally, this would contribute to students' individual development, higher quality of education and training and further professional competence development.

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