

The Development of the Applied Knowledge Base of Technical Universities Students

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Abstract

The new educational paradigms' implementation requires a significant change in the content and technologies of technical universities students' training. The purpose of the article is focused on opportunities' identifying to build skills and technical universities students' fundamental education achievement. A leading approach to the study of this problem is an information approach, causing significant changes in the content, transmission, and control of knowledge and contributing to the formation of professional competencies. The authors present the structure of applied knowledge base of technical universities' students, which determines the range of knowledge and skills of students and provide a framework for their professional competencies' development. The presented by the authors, model for the formation of applied knowledge base of technical universities' students is focused on the development of basic, applied and fundamental knowledge of the disciplines and can be used in the study of basic mathematical and scientific disciplines. This article is intended for educators, researchers, managers of educational organizations involved in the design of the disciplines' content of educational process in technical universities

Keywords: higher education, engineering students, applied knowledge base, educational activity

1. Introduction

1.1 Background

Modern socio-economic conditions put before technical universities the task of staff training, which is able to fulfill the innovative activity in the refining industries of the economy, to carry out efficiently their engineering activity, possessing the complex and dynamic nature, using the latest inventions and characterized by a high level of responsibility.

In conditions of intensive technological development the system of training in a technical high school meets the following requirements: skills' development of: individual and independent work; creative work with the scientific and technical information; abilities' development; original and creative solutions' making; working capacity; individualization of learning (due to various learning abilities); formation of: mobility of knowledge, critical thinking, creativity and flexibility at

work; adaptability to rapid changes of production conditions. Collectively, these qualities form the professional competence of the graduate, clear understanding of all manufacture processes corresponding to the achievements of scientific progress.

For the technical specialist his or her personal mental development and the ability to think logically are impossible without a fundamental education for creating a culture of thinking, logic and creativity, providing the relationship between the many objects and events. Each graduate must possess fundamental and creative applied knowledge, logic, as the basis for all creativity, mathematics' toolkit as a universal tool for design and research of statistical and dynamic models of phenomena and processes, optimization of their characteristics. The student uses mathematical modeling techniques based on information transferring about the real object; fulfills analysis of the processes taking place in the technical device; accepts compromise solutions, which are appropriate to technical devices, environment, etc; uses technical specification that contains the requirements to the main characteristics of the device taking into account all the constraints.

1.2 Status of a problem

Freedom in correction of technological cycle disciplines' course is very small, there are stringent requirements of the FSES (federal state educational standards) on the one hand and there is a need for a creative individual approach using to learning process on the other hand, which make a fundamental contradiction in methodical problems' solving in technical subjects' teaching. The second contradiction of the problem how to form professional competences of the high technical school's graduate is connected with the fact that when students' teaching to think independently and creatively solve a set of non-standard problems, it's very easy to miss the basic fundamentals of the course (for example, for a lot of applied math programs it is easy to solve standard math problems, giving a ready answer). The third contradiction is due to the need of courses' constant updating in a technical College and the complexity of continuous modernization of teaching processes of students' professional training.

1.3 The research hypothesis

The solution to the problem how to teach students to think creatively and independently is complicated by such factors as: the perceptual difficulty of educational material because of a certain kind of logic of the students, the insufficient level of pre-University training, individual student spaces, in addition, the curricula are built, usually based on just the memorization of definitions, formulas, theorems and other things, far from personal creativity techniques.

From our point of view, the development of technical university students' creative training can be achieved by developing in students of applied knowledge base of the subject area on the basis of personal creative approach which is the implementation of the paradigms of modern education and training.

2. Methodological Framework

2.1 Methodological approaches of the research

For the formation of applied knowledge base for engineering students we used the following methodological approaches: competency-based, learner-active, creative and informative.

Competence-based approach that defines modern education provides guidance on the relevance of students' learning results in social and economic practice through the formation of graduate's (specialist) personal abilities to solve a range of problems (competence) based on a formally described quality – competence (Hutorskoy, 2003; Zimnya, 2006; Mukhametzyanova, 2010, etc.). Often, the competence approach is contrasted with knowledge based approach, when only system of student's knowledge is formed, without practical orientation, significantly complicating the professional adaptation of University's graduates. The benefits of competence-based approach are in significant changes in the educational process: educational standardization's increasing through uniform requirements to the University's graduate qualities, the emphasis is made not on the content of the training, but on a set of all competencies generated through training; changes in the content of education and its focus on practically oriented direction of professional tasks' solution; the assessment of student achievements throughout the period of study (the formation of a set of competences and their cumulative system), and, consequently, changes in the methods of learning activities' control.

Creative approach, the purpose of which is providing a personal level of profession mastering, students' abilities development, the achievement of the professional ideal. This approach defines the organization of the students' learning

process through the contradictions resolution (Andreev, 2003) which requires objective (social, financial) and subjective personal conditions (knowledge, skills, creative abilities). The result of the creative academic work is original result with the novelty effect. This aspect encourages students to grow and upgrade themselves by providing conditions for self-knowledge, self-improvement, self-education.

The personality-activity approach is focused on taking into account of learning individual nature by each student, abilities, capabilities and features (Bondarevskaya, 1996; Zeer, 1998; Serikov, 1998, etc.). As means to implement this approach in technical universities students' training can be called the construction of individual educational trajectories based on the use of individual tasks of multi-level complexity corresponding to the respective abilities of students, carried out with the coordinating and Advisory activities of the teacher.

Informational approach is based on the theory of reception, conversion, transmission and assimilation of information in the educational process (Khutorskaya, 2002, etc). Its implementation in modern specialists' training is caused not only by the technological capabilities of computer hardware and software, but also by new opportunities in learning, refining knowledge and skills, systems of control, based on the actions of the teacher, access to vast informational resources, the theory of the use of visual media and technologies. This approach allows from a unified position to provide substantive, technological and communication functions of the learning process.

2.2 Principles of research

Pedagogy of technical subjects' teaching is based on General pedagogical principles, providing a holistic system approach, the relationship between phenomena, causal relationships in technical universities students' training (Babanskii, 1995; Slastenin, Isaev & Shiyanov, 2002):

The principle of consistency means that the emerging professional and General cultural competence of students of technical universities form a system, i.e., the competence, the ability and willingness of practical implementation of the acquired knowledge, abilities and skills.

The principle of science means to develop in technical universities' students the system of scientific knowledge for their comprehension and the use of modern scientific base of disciplines, scientific terms.

The principle of fundamentality is aimed at systemic building of bases and linkages between the various processes of the surrounding world, which can be guided in practice and which leads to the selection of the most meaningful and sustainable learning content.

The principle of professionalization defines the identification of the most important professional tasks which can be solved on the basis of the knowledge obtained in each subject and the development of special classes aimed at the formation of professional knowledge and skills.

The principle of accessibility means the implementation of continuity, gradualness and continuity in educational process based on personal abilities of a student. There is a focus on the individual student and individual learning trajectory is implemented here.

The principle of adaptability determines the possibility of the unification of educational technologies and techniques that have the properties of algorithm, unification, the possibility of replication in other teaching environments.

To implement the goals for the formation of students' applied knowledge base the specific guidelines to ensure the implementation of educational technology were identified:

- 1) *the Principle of "starting point"* when the knowledge system is based on fundamental definitions of the basic disciplines (mathematics, physics, chemistry), allowing to implement various technological projects.
- 2) *the Principle of internal growth of knowledge (core and shell)*, when the stable core of the system (fully meaningful and refined knowledge) identify the growth opportunities of the entire system of knowledge (shell);
- 3) *the Principle of universality*, supports the universality of the used scientific apparatus, methods, and solutions to professionally-oriented tasks.

2.3 Informational aspect of students' training

Information is a reflection of the external world by means of signs or signals, where the value of information depends on how it reduces the uncertainty of the system, i.e. increases the amount of knowledge about it. Under the applied knowledge base, on the base of developments in the field of computer science is understood the set of knowledge, that is information which is suitable for further growth of knowledge, work and management actions. For students this means that the data which are conditionally situated in the knowledge base can be successfully implemented in professional activities, i.e. they form the basis for professional competences' development.

From this point of view, the improvement of professional training can be achieved with the formation of applied knowledge base of the subject area in technical university students. In this case, the term "information" is understood as part of knowledge, which is used for orientation, action and management to improve and develop technical systems, and includes many components:

- Retrospective knowledge of the Sciences (mathematics, physics, chemistry, computer science) received in school;
- Information, as information about objects and phenomena in the environment, their parameters, properties, and condition, which reduce the degree of uncertainty, incomplete knowledge about them;
- Information, as a measure of complexity of the structures, which, gradually studying the subjects simultaneously decreases (understanding of issues take place), and increases (the understanding of the limits of science and the degree of approximation to them take place);
- Information, as the probability of selection, which provides the possibility of students' personal qualities manifestation, such as motivation, ability, readiness, etc.;
- The content of the process of information's reflection that determine not only the selection of disciplines' content, systems of tasks for learning but teaching technologies and teaching methods;
- Knowledge as a result of the process of reality cognition in the form of concepts', prepositions' and theories' perception;
- Knowledge, which is used for orientation, activity, control, i.e. for the conservation and improvement and development of the system.

Applied knowledge base of students is an integrated set of knowledge and skills of disciplines throughout the study at a technical University, where a creative implementation of the students' education is an optimal way to organize interdisciplinary connections between related disciplines in accordance with the principles of pedagogy.

3. Result

3.1 The model of formation of students' applied knowledge base

The development of the students' applied knowledge base is built on the implementation of the modern paradigms of education, which have a mission to form a competent, knowledgeable professional with high creative abilities and overall professional culture, providing adaptation to work in the professional sphere (Fig.1). To achieve these objectives it is necessary:

1. Creating an effective learning management system which is based on the following steps: the goal setting, the accumulation of pertinent information, prediction of students' learning results, decision making on the choice of pedagogical technologies, techniques and methods to develop competencies of students, implementation of curriculum, monitoring and correction of the educational activities to achieve maximum training efficiency (Kolesnikova, Gorchakova - Sibirskaya, 2005).
2. *Organization of cognitive activity* by obtaining new knowledge, practical skills' development and learning activities' experience gaining created in case professional environment, the organization of communicative interactions (Pidkadisty, 2005; Sadykova, 2013).
3. *Organization of creative activity*, allowing students to be uncovered, to show their skills and potential through creative capabilities' diagnostics and the creation of pedagogical conditions for their development through active and interactive forms of training, research and project activities (Maksimov, 2007).
4. *Organization of problem activities* based on solving of problems such as intellectual difficulties for the student and requiring reliance on existing knowledge and skills, comprehension of the task, study and search for solutions' variants (Slastenin, Isaev, Shiyarov, 2002).
5. *The organization of the programmed training* for the assimilation of established by curricula of basic themes of the discipline through an ordered sequence of tasks, an automated control system that allows to specify for each student his or her own trajectory of material learning, to provide opportunities to conduct a focused training and informational process (Bespal'ko, 1970).

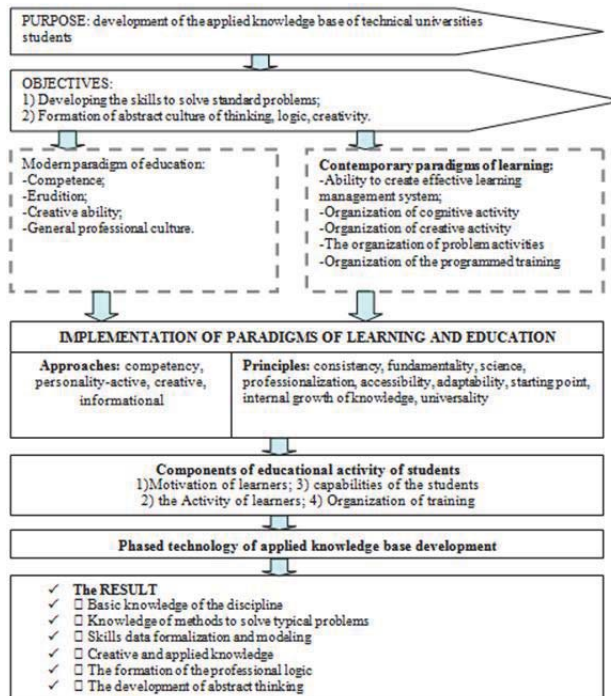


Figure 1. The model of formation of students' applied knowledge base

3.2 The implementation of students' subjective activity in the process of the applied knowledge base's development

When designing the content of academic disciplines of scientific and mathematical cycle it is important to take into consideration the fact that creative part of learning as an activity that generates something new, characterized by originality and uniqueness, implies a significant taking part of the entity of the creative activity – University student, whose educational activity includes the following components: motivation of the learning process, the activity in the learning process and abilities in the subject area.

In relation to students' learning activities, motivation of educational activity (motivation of achievement and motivation of cognition) is reflected in the fact that the student taking the goals and objectives of learning is engaged in active learning activities. Furthermore, the motivation of educational activity (external and internal) stimulates the activity of the learners in this activity: cognitive motivation includes internal and external motives for entering the higher school, wide educational and professional concerns, providing the basis for the cognitive activity; the motivation to succeed, coupled with the professionally-oriented activity enhances the effectiveness of training activities.

The level of abilities of the learner, as one of the factors of students' educational activity provides the ability to acquire knowledge, skills and successfully apply them in problems' solving, with creative ability which is in the ability to generate independently new knowledge through creative activities:

- 1) Ability of a trainee to sort, allowing to switch attention from one subject to another, with the recognition of the desired one. This ability is very limited - the average person can confidently (without getting off) to cycle through the range of 1000 elements and to act taking into account this limitation;
- 2) Ability to abstraction, through which people can combine different objects or samples in one concept, to replace multiple items with a single element (of another kind) and thereby to overcome the limits of enumeration;
- 3) Ability to induction allows to deal with infinite sequences and move from evidence to hypothesis which need in proof.

Logical thinking, ability to learn, think, and judge, the basic mathematical apparatus are things in which need any

graduate of a technical College in their professional activities. For abilities of students to be in full demand and develop in the learning process, the following scheme of study is proposed (Fig.2).

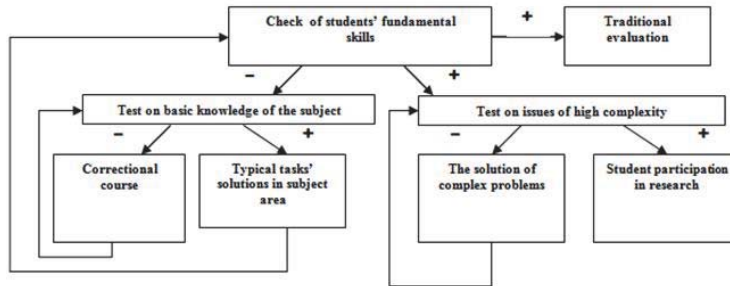


Figure 2. Interactive scheme of teaching science and mathematics disciplines

It should be noted that not all students with professionally-oriented motivation, having the opportunity to watch creative presentation of material by the teacher who uses advanced learning technologies are capable of creativity, however, the possibilities to imply creative approaches affect the personal development of all students, contributing to the growth of motivation, activity and professionalization of teaching.

3.3 An example of technology how to form the applied mathematical knowledge base of technical University students

When optimizing students' learning activities through their creative and mathematical training it is necessary to take into consideration that each specialist - graduate should possess the fundamental and creative and applied knowledge of mathematics, mathematical logic as the basis of any creative work, while receiving a universal tool – mathematical apparatus for the construction and study of statistical and dynamic models, optimization of their characteristics.

So the following stages of technology how to form applied mathematical knowledge base using software packages and programming tools are proposed:

- 1) Study of the theoretical foundations of the subject;
- 2) Skills mastering for typical tasks solving;
- 3) Connections and relationships study between phenomena and processes
- 4) Mathematical modeling and engineering of phenomena and processes in conditions of partial uncertainty;
- 5) Study of numerical methods for engineering problems solving;
- 6) Development of algorithms for problems solving;
- 7) Development and adjustment of software for tasks solution;
- 8) Analysis of solving results.

With such a construction of the students educational process, when the material is a fundamental and applied by nature, not only formal memorization of terms, but the process of creating of their own calculations program is provided, that is the creative activity that ensures the absorption of the material and contributes to creative problem thinking of the future specialist is provided.

Approbation of the proposed approach showed that the majority of students in the experimental group (147), almost every student of which (91,7 %) possess basic applied and fundamental knowledge of mathematical disciplines cycle; applied skills of problems formalization in the subject area; ability to design software for problems solving with computer equipment; the skills to solve non-standard tasks (while the presence of certain abilities of the student), thus the applied mathematical knowledge base of technical universities students is formed and contributes to the continued professional and academic growth of students in selected subject areas.

4. Discussions

An engineering graduate must be in any professional situation capable of systemic activity, involving the analysis, design and implementation in the conditions of uncertainty of the environment, and, therefore, requires creativity and creativity

abilities, quick thinking and decision making. The goal of every academic discipline is the acquisition of new knowledge for students (including interdisciplinary connections), obtained independently as a way of reality cognition and, therefore enabling the transformation of information into knowledge, getting the experience of their application in case professional tasks solving, and eventually acquiring the necessary competencies. In this aspect, the applied knowledge base of the disciplines that contains the basic terms, laws, relationships, events, setting, solution methods is a necessary result of educational activity of students.

5. Conclusions

Thus, the developed by the authors the structure of applied knowledge base of engineering students, used for fundamental supporting knowledge and implementation of active cognitive actions, is the basis of professional competences development. Presented by the authors the model for engineering students' applied knowledge base development allows to design the students' learning activities in the study of basic mathematical and scientific disciplines.

The obtained after the pilot research data show the development of the system of students' educational activity, their motivational-value attitude to this activity, the development of the system of applied knowledge and research skills that allow productively use them in their professional problems solving.

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