Development of engineering thinking with the use of research activities in the field of plant raw materials deep processing

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Abstract. Currently, in connection with the development of computer technology and modern means of communication, when the use of information technology becomes necessary in almost any field of human activity, information technology of education is increasingly being discussed. One of the priority directions of the digitalization process of modern society is the informatization of scientific research and the learning process - the introduction of new information technologies. The article discusses the role of research activities using educational information technologies in scientific research in the field of deep processing of vegetable raw materials. Stimulation of the cognitive activity of students, aimed at finding solutions to the tasks set, will contribute to the formation of skills for further professional activity.

Research activities in the educational process are activities related to the solution of students of research tasks of a creative nature. Currently, the planning, implementation and processing of scientific research results are greatly influenced by computer technologies that control all spheres of human activity. The development of science and technology makes research technologies to improve and transform, which in turn are a system of interrelated activities of a teacher and a student and are the main link for successful educational activities.

As they develop, they make it possible to expand the use of various methods and means of teaching in the system of higher professional education in order to achieve the goal and solve educational problems. In our opinion, in the future, this should lead not only to an increase in the motivation for research activities of students, but also the academic performance and effectiveness of the learning process itself.

Information educational technologies are gaining great popularity every year also because for a modern student, this form of information provision is more attractive. This is due to the fact that the generation of modern students grew up during the period of computer technology rapid development. They study the world around them with the help of computer games, prefer virtual communication in social networks to live communication. It is easier for them to share their inner world and discuss their experiences, joys and doubts with thousands of virtual interlocutors than in personal communication with friends or parents. In this regard, scientific research and educational technologies are undergoing tremendous transformations, computerizing and systematizing knowledge.

M. Sandomirsky [1] emphasizes that the further, the more noticeable will be the intellectual and cultural stratification of youth. At one extreme there is a smaller part of young people who are interested in knowledge, who study intensively, and knowledge for them is of high value. And on the other pole
- most of the youth, for whom, on the contrary, culture, education, knowledge are devalued and lose value. Since they believe that you can get well in life without having special knowledge.

In connection with the above stated, the development of professional education in modern conditions should be accompanied by the ability of teachers to design and implement new information educational technologies and be considered an integral part of the teacher's competence.

The term information technology in modern science is considered from various points of view. So, for example, I.G. Zakharova [2] considers the concept of "Information technology" as:

- a system of scientific and engineering knowledge, as well as methods and means that are used to create, collect, transfer, store and process information in the subject area and information technology training;
- it is a pedagogical technology that uses special methods, software and hardware to work with information. In this case, information technology is considered as a set of methods and technical means that are used to work with various types of information.

UNESCO [3] defines the concept of "Information technology" - as a complex of interrelated scientific, technological, engineering disciplines that study methods of efficient organization of the work of people involved in processing and storing information; computing technology and methods of organizing and interacting with people and production equipment, their practical applications, as well as related social, economic and cultural problems. This definition is based on a set of different disciplines that study the methods of organizing the work of people whose occupation is in one way or another connected with information and everything connected with it.

Danilevsky Yu. G. [4] believes that information technology is a set and description of the processes of circulation and processing of information. The objects of processing and circulation are information, data. Technological routes and scenarios of information processing processes can be used as components of descriptions.

According to GOST 34.003–90 [5] information technologies are techniques, means and methods of using computer technology when performing the functions of collecting, storing, processing, transmitting and using data.

Thus, information and educational technologies are a combination of the use of various types of information, methods and teaching aids that contribute to a more effective organization of educational activities, enhancing the cognitive and mental activity of students.

Due to the fact that at present information technologies are being actively implemented in various areas of industry, the need for highly qualified engineering personnel is increasing; they must be capable of:

- to apply general education and polytechnic knowledge in modern production in the areas of design, organizational and management, production, technological and research activities;
- set a realistic goal, taking into account technical, material, time, energy and other resources, choose adequate technical methods and means, plan the sequence of your actions, determine the degree of goal achievement, if necessary, dialectically correct it, make timely changes to the project being implemented.

All this once again underlines the need to develop engineering thinking in future graduates of technical universities. Since it is engineering thinking that is associated with the transformation of the surrounding world. Indeed, even at the stage of creating models (drawings, diagrams, algorithms, etc.), it is not possible to do without the mental correlation of these models with reality in the further material embodiment. And the practical inability to transformative activity leads to the inferiority of thinking itself, which manifests itself in the absence of intuitive prediction of the course of real processes, in the appearance of errors in logical constructions associated with inaccuracy in highlighting essential characteristics in the design process [6].
Lecturers of the Industrial Technologies Machines and Apparatus Department of the Siberian State University named after M. F. Reshetnev, use information and educational technologies, both in teaching technical disciplines, and in scientific research.

For example, in the process of research activities, students in the laboratory “Deep processing of vegetable raw materials” analyse the ongoing processes in various types of grinding equipment using modern programs for modelling physical phenomena [7, 8]. With the help of these programs, students simulate various physical processes taking place in modern pulp and paper, petrochemical and chemical equipment. Using various simulation tools for grinding equipment, the required geometry is obtained from the instructor-given structure (for example, a disc mill). Then the necessary formulas for the calculation are selected by specifying the input and output parameters and the process is started for calculation. As a result of calculations, students can clearly see the hydrodynamic processes taking place in a disk mill (figure 1 a).

Then, in the classroom laboratory for grinding fibrous semi-finished products, they study the device, the principle of operation of the grinding equipment and practice practical skills of working with it (figure 2).

**Figure 1.** 3D model of a disc mill: (a) pressure distribution in a disc mill; (b) a set with crescent-shaped curved knives.

**Figure 2.** Schematic of an experimental knife milling plant 1-pulper, 2-belt drive, 3-injection pipe, 4-circulation pipe, 5-hold, 6,7,8-electric motor.
Building multiphysics models of experimental laboratory facilities allows students to conduct experiments and calculate the optimal operating conditions for equipment even before visiting the laboratories. Modelling makes it possible to facilitate research, to make available the determination of the quantities of interest, to artificially reproduce the phenomena under study, helps to reveal the interdependencies of variables, the nature of their change over time, and to find existing patterns [9].

Figure 3 shows a model of a hydraulic piston with an extension and a nozzle without a knife laboratory installation of the “jet-barrier” type. The use of multiphysics modelling in this case allows you to experimentally test various modes of fluid flow, establish and confirm theoretical regularities, familiarize yourself with experimental techniques, establish the properties of a substance, their qualitative and quantitative characteristics, observe and develop phenomena, processes, and test algorithms.

![Image](image_url)

**Figure 3.** Model of a hydraulic piston with an extension and a nozzle of a knifeless installation of the “jet-obstacle” type (pressure 12 MPa): (a) movement of a fibrous suspension; (b) pressure distribution at the outlet of the packing.

As a result, modelling the flow of fibrous suspension in a knife disk mill and in a knifeless installation of the “jet-barrier” type immerses students in the real conditions of the production process, contributes to the formation of cause-and-effect relationships, better assimilation of educational material, increases cognitive activity in educational activities to the academic subject making educational activities more meaningful, interesting, exciting and productive [10,11].

Thus, students, without additional visits to basic enterprises, visually study and analyse various physical processes, thereby saving personal time and material and technical resources of the educational institution.

Moreover, they not only clearly see the processes occurring in the equipment, but also plan the sequence of their actions, and, if necessary, correct and promptly make changes to the process under study.

As a result of the above software inclusion in the educational process, students develop visual-effective, creative and productive types of thinking, skills in modelling work equipment and physical processes, designing mechanical engineering products, organizing their work, mastering computer methods of collection, storage and processing information used in the field of professional activity. All this forms the student as a highly qualified specialist with the necessary competencies that allow him to form skills for further professional activity.

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