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Intellectual mobility and the model of its formation in engineering students

Introduction. Technological achievements in the modern society are accompanied with constant flows of information, which requires training competitive engineers at a new level, as in such a situation it is impossible to give all necessary knowledge and skills that can ensure effective productivity throughout the whole life of a professional. The educational system has to quickly respond to the transformations of the world. The Fourth Industrial Revolution has begun, and the Future of Jobs Report [4] considers its features and analyses the changes in the employment, skills and workforce strategy. It argues that entire industries are undergoing transformations: some jobs are becoming unnecessary, and the new ones appear and develop fast, the existing ones being going through the changes concerning the skills set required to them. Thus, retraining and professional development is of great importance. In 2020, the top skills will be: complex problem solving; critical thinking; creativity; people management; coordinating with others; emotional intelligence; judgement and decision making; service orientation; negotiation; cognitive flexibility [1].

All these skills are closely connected with the development of intellectual mobility, the understanding of which is changing now: from the interpretation as intellectual migration and exchange of ideas to understand it as a personal quality, which becomes the basis for mobility of a person and can be observed in different spheres of life [8]. We specify the concept *"intellectual mobility of a future engineer"* and define it as an integrated characteristic of a personality that ensures his/her readiness to find, process and effectively apply increasing information flows, to produce new ideas and perceive innovations with tolerance; promptly choose the effective ways to solve both reproductive and creative tasks, as well as quickly change the types and forms of intellectual activity without reducing its productivity [3].

The development of key skills and personal competencies necessary for the professional in the 21st century has resulted in the need to rethink the role of a foreign language in the professional development of a specialist and, accordingly, to create models of learning a foreign language takes into account the features of the current stage of educational development (interdisciplinary integration, use of information and communicative technologies (ICT), etc.). The essence of the vocational-oriented teaching of a foreign language, for example English for Specific Purposes (ESP), should be reconsidered. We argue that foreign language teaching process itself should be involved in the development of key skills and competences of future professionals and believe that ESP can become a means to develop intellectual mobility of engineering students in a technical university.

The analysis of scientific works in the fields of pedagogy and psychology, as well as the study of experience in professional training of future engineers allowed us to develop the structural and functional model of the formation of intellectual mobility in engineering students through the integration of professional training and teaching ESP, which was successfully implemented during the pedagogical experiment in the educational environment of a technical university [3]. **The purpose of the article** is to present this model and describe its components.

It is important to mention here that a model is an imaginative or physically realised structure which can replace the subject of research. The model is both a system which represents the subject of research (for example, simulates optimisation of the structure of the teaching process) and a means of theoretical investigation of pedagogical phenomena through imaginative creation of living situations [11].

Our structural and functional model of the formation of intellectual mobility in engineering students is based on the following pedagogical principles: 1) modelling the process of the formation of intellectual mobility in engineering students should be considered in the relationship of personality and activities in future: professional activities cannot be carried out without the formation of necessary skills and qualities, as they are evaluated and developed in these activities; 2) the model is a benchmark for solving the issues of improving the effectiveness of professional training, in our case – to develop intellectual mobility effectively; 3) the model represents the main positions of the studied process, summarizes the results and enables us to control the process of the formation of intellectual mobility; 4) basic principles of modelling – clarity and objectivity – determine the capabilities of the model as well as its functionality in the process of formation of intellectual mobility in future engineers; 5) theoretical model is holistic and functional, all its components have a clearly defined purpose and are in the systemic interconnection and dynamic unity.

The main components of the model are: methodological, process-and-content and result-and-evaluation ones (Fig.1). Let us consider all of them.

The *methodological component* includes the purpose, objectives, methodological approaches and principles, as well as the factors of an educational environment of a technical university that influence the formation of intellectual mobility.

The objectives of the model are: 1) to develop intellectual capabilities, competences and personality traits that ensure the readiness of a student a) to find, process and effectively apply increasing information flows, b) to produce new ideas and perceive innovations with tolerance, c) to choose the effective ways to solve tasks and quickly change the types of intellectual activity without reducing its productivity; 2) to manage the educational process based on of subject-subject interaction and in the context of intellectualization of professional training.

The unity of systemic, environmental, personality-oriented and activity-based as well as integration approaches determines the methodology of our research. The systemic approach [5] allows considering the process of formation of intellectual mobility as a system and designing a model of this process, in which all elements of professional training are harmonized and interconnected. The environmental approach [12] allows us to shift the activity of a teacher from the active pedagogical influence on

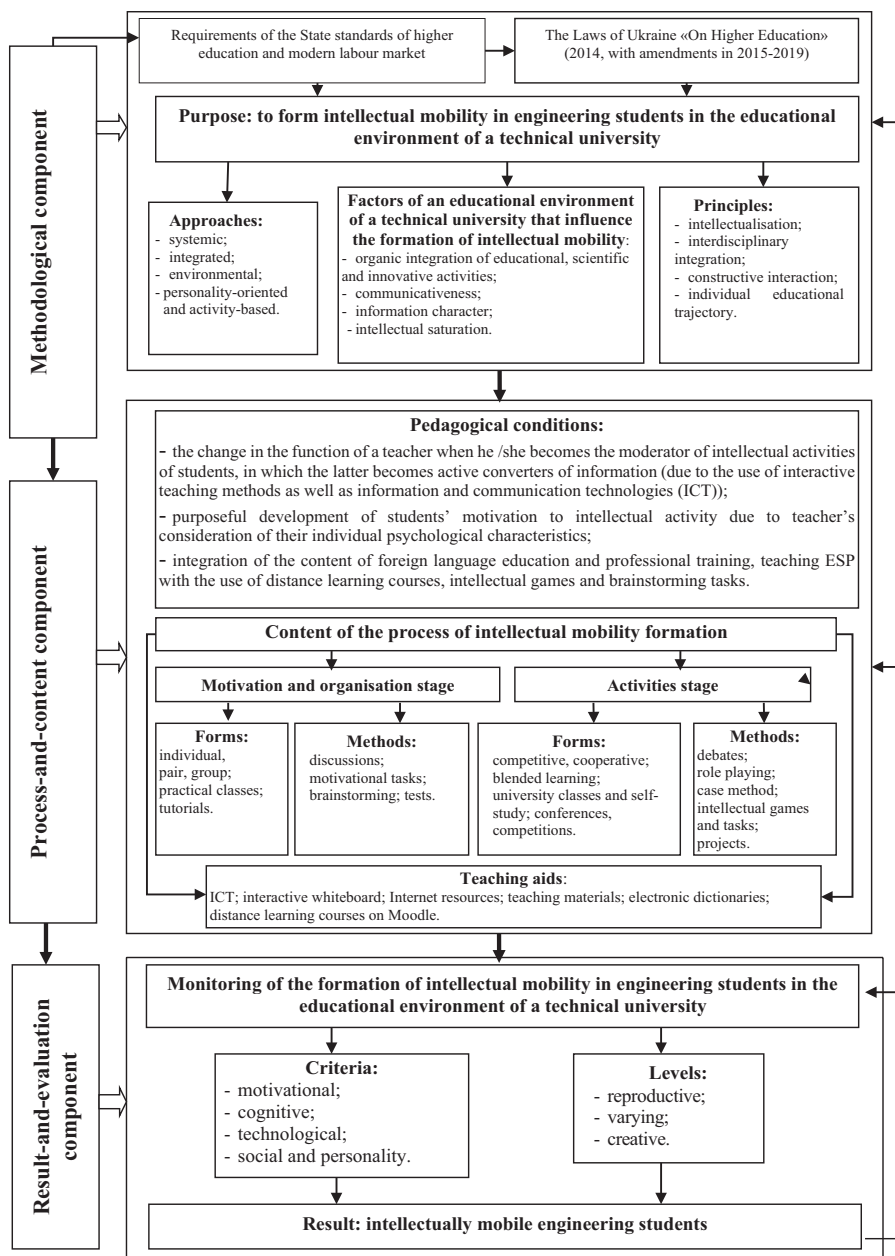


Figure 1. Structural and functional model of the formation of intellectual mobility in engineering students

the student to the active use of educational information-rich environment in which his/her self-study and self-development takes place.

The personality-oriented approach [6] views an individual as the main value of the educational process. Personality-oriented teaching should ensure the development and self-development of the student's personality as a subject of cognitive activity; it should provide every student, based on his /her abilities, interests and experience, with the opportunity to realize himself /herself in different activities. The activity-based approach [9] involves reorientation of teaching from traditional memorising of ready-made forms of knowledge to the process of their acquisition and functioning.

The integrated approach [10] in the formation of intellectual mobility means the integration of fundamental, professional knowledge, knowledge of humanities and the development of system thinking skills based on of interdisciplinary connections. It is important that the integrated approach to the teaching of the discipline develops from the harmonization of the content of education to in-depth interaction and integration of knowledge and skills of future professionals.

Principles of teaching and learning govern the overall organization, content, methods and forms of the educational process, the nature of teacher-student interaction, etc. The formation of intellectual mobility is based on the following principles: intellectualization; interdisciplinary integration; constructive interaction; the principle of choosing an individual educational trajectory.

Yegorova [7] introduces the principle of "intellectualization" as a priority in professional training in the 21st century, since the main characteristic of modern society is the essential intellectualization of work in all spheres. The realization of this principle is connected with intellectualization of forms, means, methods, content of education, which will ensure the formation of components of intellectual culture: intellectual mobility, intellectual competence, intellectual activity, responsibility, initiative.

The intellectualization of professional training implies the need for integration of academic disciplines. In our study, the principle of interdisciplinary integration predetermined the integrative influence of general professional training and foreign language teaching, especially ESP, which has contributed to the formation of intellectual mobility of engineering students.

The principle of constructive interaction means participation and cooperation of both teachers and students in the design and optimization of the educational process, as well as their satisfaction with this interaction. In the formation of intellectual mobility, it is important to reorient the activity of the teacher from informative to scientific-organizational activity, aimed at intensifying the research work of students.

The principle of choosing an individual educational trajectory implies the possibility of choosing an educational route within the university. The student has the right to agree with the teacher the pace, forms and methods of learning; he/she can choose the form of representing a project, take part in the evaluation of the results. Here it is necessary to develop students' planning and time-management skills, objective mutual and self-assessment.

Since the purpose of our study is to develop intellectual mobility as a quality of a personality in the educational environment, we included the following characteristics of such an environment in the methodological component of our model: organic integration of educational, scientific and innovative activities; communicativeness of an educational environment; information character, and intellectual saturation of the educational environment.

The *process and content component* performs a regulatory function and includes the pedagogical conditions for the formation of intellectual mobility of future engineers, the content of this process, as well as the forms, methods, and teaching aids necessary for the implementation of this process.

The core of the model is the pedagogical conditions: 1) the change in the function of a teacher when he /she becomes the moderator of intellectual activities of students, when the latter become active converters of information (due to the use of interactive teaching methods and ICT); 2) purposeful development of students' motivation to intellectual activity due to teacher's consideration of their individual psychological characteristics; 3) integration of the content of foreign language education and professional training with the use of distance learning courses, intellectual games and brainstorming tasks.

The tasks of the formation of intellectual mobility were realized in two consecutive stages: 1) motivation and organizational stage; 2) activities stage.

The purpose of the motivation and organizational stage was to study the students' motivation for intellectual activity, for mastering a foreign

language and special disciplines, as well as to acquaint students with the purpose of research, to explain to students the importance of intellectual mobility for their professional self-realisation.

The main stage of the formation of intellectual mobility is the activities stage, in the process of which the development of all components of intellectual mobility is realised [8]. The following methods were used: debates, business games, role-playing, case method, intellectual games, and projects.

No principles and methods of learning can provide the conditions for effective study unless the appropriate organizational forms are applied. During all the stages, depending on their tasks, we used various forms of organization in the process of teaching ESP: individual, pair, group work, both competitive and cooperative. Practical classes, tutorials, students' scientific conferences, competitions of presentations were held.

Table 1. Criteria and characteristics for assessing the level of the formation of intellectual mobility

Criteria	Characteristics
Motivational	- understanding the importance of intellectual development; - profound interest in intellectual activities;
Cognitive	- knowledge about intellectual mobility and personal psychological characteristics; - qualities of thinking (flexibility, agility, profundity and criticism of thinking); - thinking operations (analysis, synthesis, generalization, comparison, concretizing, abstracting); - creativity in intellectual activity;
Technological	- instrumental competences (written and oral communication in the native and foreign languages, computing skills, information management skills); - using the strategies and techniques of doing the intellectual activity
Social and personality	- adaptively important personality traits, namely: businesslike efficiency, emotional stability, activity, responsibility; - communication skills; - persistence in achieving the goals; - tolerance, recognition of the view diversity

Creating an information resource for the distance learning system on platform Moodle allowed us to put into practice the elements of blended learning [2].

Among the teaching aids used for the formation of intellectual mobility were ICT tools, an interactive whiteboard, Internet resources, electronic textbooks, distance courses, dictionaries, encyclopedias, etc.

The third component of the model – *result-and-evaluation* – performs the monitoring function in the study. It includes the criteria for the formation of intellectual mobility in engineering students (motivational, cognitive, technological, social and personality) with corresponding characteristics (Table 1) which, in complex, establish three levels of intellectual mobility: reproductive (low), varying (medium), and creative (high).

The reproductive level of intellectual mobility means elementary manifestation of all the characteristics given in Table 1; the varying level is characterized by a situational manifestation of such characteristics; therefore, the high level of intellectual mobility can be achieved at the level of creativity.

In addition to identifying the level of formation of the elementary mobility, the task of the result-and-evaluation component of the model was to develop students' cognitive and reflexive skills, the ability to self-organization, self-regulation of intellectual activities and assessment of their own intellectual abilities.

Conclusions. The development of the structural and functional model can become an effective tool for both representing and realising the process of formation of intellectual mobility in engineering students in the environment of a technical university. The components of this model should be in a systemic interconnection, properly considered and objectively analysed. They include: purpose, methodological principles and approaches, characteristics of the educational environment of a technical university favourable for the intellectual development; pedagogical conditions, content, stages, methods, means and forms of training through the integration of professional education and teaching ESP; criteria for assessing the levels of the formation of intellectual mobility as a quality of successful engineering students.

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Abstracts

MICHNENKO HALYNA, KUCZERIAWA LIUDMYŁA. **Intelektualna mobilność studentów specjalności inżynierskich i model jej kształtowania.** Artykuł dotyczy mobilności intelektualnej studentów specjalności inżynierskich jako ważnej cechy, niezbędnej do ich udanej działalności zawodowej, którą można ukształtować w środowisku edukacyjnym uczelni technicznej, zapewniając integrację kształcenia zawodowego i nauki języków obcych. Artykuł przedstawia strukturalno-funkcjonalny model kształtowania mobilności intelektualnej. Opisano podstawowe bloki modelu (metodologiczny, merytoryczno-proceduralny, oceniający) i ich elementy składowe. Należy zauważyć, że taki model może stać się skutecznym narzędziem do prezentacji i wdrażania procesu kształtowania mobilności intelektualnej jako cechy przyszłych inżynierów.

Słowa kluczowe: mobilność intelektualna, model, angielski do specjalnych celów, aktywność intelektualna, warunki pedagogiczne.

МІХНЕНКО ГАЛИНА, КУЧЕРЯВА ЛЮДМИЛА. **Інтелектуальна мобільність студентів інженерних спеціальностей та модель її формування.** У статті розглядається інтелектуальна мобільність студентів інженерних спеціальностей як важлива якість, необхідна для їхньої успішної професійної діяльності, що може бути сформована в освітньому середовищі технічного університету шляхом забезпечення інтеграції професійної підготовки та навчання іноземної мови. У статті

представлена структурно-функціональна модель формування інтелектуальної мобільності. Описано основні блоки моделі (методологічний, процесуально-змістовий, результативно-оцінний) та їхні складові. Зазначається, що така модель може стати ефективним інструментом представлення та реалізації процесу формування інтелектуальної мобільності як якості майбутніх інженерів.

Ключові слова: інтелектуальна мобільність, модель, англійська мова для спеціальних цілей, інтелектуальна діяльність, педагогічні умови.

МИХНЕНКО ГАЛИНА, КУЧЕРЯВАЯ ЛЮДМИЛА. **Интеллектуальная мобильность студентов инженерных специальностей и модель ее формирования.** В статье рассматривается интеллектуальная мобильность студентов инженерных специальностей как важное качество, необходимое для их успешной профессиональной деятельности, которое может быть сформировано в образовательной среде технического университета путем интеграции профессиональной подготовки и преподавания иностранного языка. В статье представлена структурно-функциональная модель формирования интеллектуальной мобильности. Описаны основные блоки и компоненты модели. Отмечается, что такая модель может стать эффективным инструментом представления и реализации процесса формирования интеллектуальной мобильности как качества будущих инженеров.

Ключевые слова: интеллектуальная мобильность, модель, английский язык для специальных целей, интеллектуальная деятельность, педагогические условия.

MIKHNENKO GALYNA, KUCHERIAVA LIUDMYLA. **Intellectual mobility and the model of its formation in engineering students.** The paper focuses on intellectual mobility of engineering students as an important quality necessary for their successful professional activity, which can be developed in the environment of a technical university through the integration of professional training and teaching a foreign language. The structural and functional model on the formation of intellectual mobility, previously developed and realised by conducting a pedagogical experiment, has been presented in the paper. The main components of the model (methodological, process-and-content, result-and-evaluation) and their constituents have been described. It is stated that such a model can become an effective tool for representing and realising the process of the formation of intellectual mobility as a quality of future engineers. **Keywords:** intellectual mobility, model, English for Specific Purposes, intellectual activity, pedagogical conditions.