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AXIOLOGICAL FOUNDATIONS OF PHYSICS AND TECHNICAL SUBJECTS STUDY OF THE FUTURE ENGINEERS

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Abstract.

Formulation of the problem. Formation and development of the value orientations of the individual is the groundwork of education of young people at all educational levels. Necessity for axiologization of the process of education of the future engineers is strengthened by the specifics of technical and technological activity in the situation of the widespread use of ICT. Integration of value-motivational factors with the physics and technical disciplines study is an actual aspect in the development of modern higher technical education. **Methods.** The research uses a conceptual and comparative analysis of psycho-pedagogical and methodological literature, innovative experience and generalization of the authors' long-term experience in pedagogical activity, as well as observation, conversations with teachers and students of higher educational institutions. **Results.** By the concretization of the functions, the essence of axiology in the system of higher education has been found out. The importance of transferring the motives of educational activity from the final result to the process and the determining role of motives for self-education has been established. The interrelations between the degree of value-motivational development of the personality and his individual characteristics are investigated. There is shown the essence of the phenomenon of attitude to study, its types have been determined. The research concretizes the place and importance of the most important professionally significant moral and ethical principles. **Conclusions.** Axiologization of higher technical education is a powerful means of forming the social, personal, subject and professional competence of the future engineer. Creation of the corresponding personally oriented didactic means is based on interdisciplinary methodological approaches in higher education.

Keywords: Axiology of education; future engineers; students' self-study; subject motivation; technical education; values orientation..

1. Introduction

Axiology as the process of valuable aspects involving in the various areas of human life is one of the leading approaches in the modern higher technical education. Categories «value», «value orientation», «structure and hierarchy of the sphere of values» and others are the field of axiology – philosophical doctrine, which investigates the values ontology [1] – [4].

Particularly relevant is the axiology approach during the wide implementation of the information and communication technologies (ICT) in the engineering education. Separation of users of the software learning products from the teacher (especially when using on-line learning technologies)

transforms the learning process into the technocratic one causing the corresponding deformation of the users toward intellectualism, promoting the development of logical thinking at the underdeveloped emotional sphere and imagination.

2. Analysis of research

According to the paradigm of professional education in the postmodern era, there are two main aspects that determine the formation of future engineers as specialists with higher technical education. Psychological aspect provides orientation of the person to self-improvement, active life and professional approach, creativity, interest and need for self-development. Social aspect provides a wide

range of professional and universal norms, values, and ideals.

The critical factor of the high-technology country development path is its ability of high-quality human capital production, ready for modification during the whole life [5], and that is based on the productive structure of personality.[6]. It is obvious that personal changes are taking place against the backdrop of persistent value and motivation orientations.

Considering the urgent need for education reform and the formation principles of the school of the future, K. Robinson showed that its economic, cultural, social and personal goals can be achieved by the value convergence in the multicultural environment, development of positive motivation in education, learning personalization, etc. [7].

Among the key words of the formula for a new Ukrainian school, which is comprised of nine key components, such definitions as the "education process for value shaping", "motivated teacher", "successful self-realization in society", "competence for life", "pedagogy of partnership", "child centering", etc. [8] could be found.

It should be noted, that the axiological traits are also comprised in the strategic directions of the state policy of Ukraine in the field of education, and are based on "the principle of human priority in ... building an efficient national education, development and socialization of children and youth system"[9].

The need for innovation in the economies of developed countries leads to a contradiction between the ever-growing lack of specialists in high-tech industries that are capable of comprehensive scientific and engineering activity and low level of awareness of the value of natural and mathematical knowledge and the motivation for its mastering by students [9].

The axiological context is enclosed in the essence of the skills of the 21st century, among which there are abilities to argue value positions, responsibility for making decisions, interest in difficult tasks, readiness for professional growth throughout life [11].

The value concept is a key one in the modern public opinion. It is used in philosophy, sociology, psychology, and pedagogy to describe objects and phenomena, their properties; it embodies moral ideals and acts as certain standards [1]. In the scientific studies, the notion of value orientations is used to determine the hierarchy of interests and needs of a person, the importance of certain events

in the individual conscience that determine the person maturity and professionalism [4]. The values orientation of national education through "the physical, moral, spiritual, and cultural development, ... formation of the socially mature creative person, citizen of Ukraine and the World, organizing young people for informed choice of the fields of vital activity" is declared at the national level [9].

Axiological approach in the higher technical education is a part of postmodern philosophy. It acts as a means of resolving the contradictions of modern society. The main factors stimulating appeal to value-motivational principles in pedagogy are the break and subsequent inversion of social and cultural cycles, avalanche-like information growth, revolution in the modern science, and significant expansion of human responsibilities. It leads to the development of synergistic approaches in the social sciences, the presence of multiple choices causing possibility of the loss of reference points and hierarchy of values [12].

According to the Karl Popper theory [12], process of research of the objective content of thoughts, scientific ideas, and works of art under conditions of the oversized information space requires the presence of a flexible, creative and critical approach.

Considering education as a means towards freedom, P. Freire notes that persons are learned to dialogue based on openness, trust, and desire to cooperate by means of the solving problematic situations and overcoming external pressure and obstacles; this allow to the persons cope with internal limitations and extend the capabilities.

Therefore, axiology in the modern education is the effective instrument of transformation of society in the direction of freedom of choice, critical thinking, and dialogue between the subjects of study [12].

Sources and motives of development and personal growth are the inner properties of a person; it is the fundamental thesis of the individual oriented pedagogy, one of its founders is Abraham Maslow. The main task of the teacher in the learning process is assistance to the person self-understanding, mobilization of inner strength and ability for productive action [14].

Multipurpose study of the values specifics in education conducted by Kyr'yakova and others [15] proved the openness and dynamism of the education systems aimed at education filling by personal content and value categories.

We know that the most important factor for successful learning in the higher education is the nature of learning motivation, its energy level and structure. In classical psycho-pedagogical literature, learning activity motivation is divided into insufficient and positive. The latter includes educational, professional, and personal ideals, motivations, needs and interests, aspirations and emotions [1], [4], [17]. Ilyin classified motives that act in the education system by types, levels, trends, and content [18]. Cognitive interest according to Vygotsky is estimated as the positive attitude to the activity [19].

S. Rubinstein [20] identified the cognitive and business stimuli as the main educational motivations. This means that the person doing some cognitive activity is aware of its importance for getting some vital goods in the future.

Motives are differentiated by trend and content as social, educational, professional, aesthetic, communicational, helpful to status, historical, utilitarian, and practical (mercantile) [4].

There are external and internal motives [20]. The source of the first is society, teachers, parents, and other persons; these motives act as tips, hints, requirements, instructions, forcing and so on. Their action is rather effective but not humane because it determines the internal resistance of the person. The true source of human motivation is internal. That is why the crucial motive is not teaching (external pressure) but studying incentives (internal incentive forces). In addition, it is proposed a hierarchy under which real and farfetched, conscious and unconscious, wide and narrow social motives are distinguished [20]. Direct and clear communication between positive motivation and successful learning is proved in the collective work [21]. The authors [22] have shown that the value and motivational component is included in the technological competence of the future engineers.

Thus, the scientific and educational literature analysis showed that there is a complex system of relationships between human abilities and motivation. These two factors are in dialectical unity: high positive motivation can compensate the shortage of special skills and knowledge and plays the role of a specific equalizer that does not work in reverse.

3. The purpose of the article

The above mentioned determines the purpose of the research: investigation of the axiological approach

particularities for creating a methodological system of physics and technical subjects study of the future engineers.

4. The results of research

The scientific content of axiology of education is determined by the following aspects:

- component of humanization of education that determines the composition and hierarchy of moral values where the person is the main value;

- a set of pedagogical conditions promoting development of the person, moral enrichment, and formation of the students' academic maturity;

- a process combining certain aspects of the university educational activities (the disclosure of the education reserves) and students' individuality (development of value attitude to knowledge, profession, stable professionally meaningful and social orientations that lead to the search, evaluation, selection and design of the way of life);

- a method of development of the person creative and valuable behavior, independent activities towards the professional growth and achievement of high results.

Practical experience shows that students' interest and awareness that learning process requires maximum effort should precede their involvement in the process. A teacher also has to make sure that the educational interest is directed towards the subject study but not to good mark receiving. It is well known that the educational system should be created close to life and to the future students' professional activity.

Motivation of cognitive activities is related to the internal and external needs of the person. The first one means necessity to perform certain activities and the second one determines the possibility of their implementation. It should be noted that internal needs are primary and external factors are effective only at the presence of the internal needs. Internal students' motives can be various: new experience acquiring, the respect of people, a reward, and satisfaction by the process of cognition. The transfer of motivation from the result of studies to the cognitive activity is the crucial factor that determines the learning process effectiveness.

Detailed analysis of motives of the educational activity has distinguished the following motives: knowledge acquiring, a profession obtaining, and a diploma getting. Teaching experience indicates a high degree of correlation between knowledge acquiring motives and learning success. Such a student learns regularly and purposefully. Students aimed at

acquiring a profession are inclined to selectivity of subjects on the «required» and «not necessary» for their professional growth. Focus on a diploma makes students try to find the lightest roundabout routes.

One of the fundamental rules of the successful cognitive activity states that a knowledge not supported by students' independent activity cannot become a real achievement. Our study found that the most effective in a subject study is the subject direct motivation; indirect subject motivation also can play a significant role. One of the indirect motives that can transform the interest of students to physics and technical subjects study is related to their competence in the field of ICT; teaching experience of the authors shows that some of undergraduate students already have a certain acquaintance with programming (C ++, MATLAB, Adobe Flash, etc.).

Modern technologies of independent study suppose increasing activity of students. The interactive learning technologies used in the textbooks of new generation provide significant opportunities for this. They motivate learners to maintain feedback, answer questions, and interact with multimedia systems. At the same time, the excessive use of these technologies may lead to overstress of the students' sensory organs and internal forces.

Theoretical analysis and practical study of the structure of value-motivational orientations of the students show that the following functions based on the axiological approach could be realized in the higher technical education with ICT systems using:

- methodological function that contains components of axiological thinking style as a reflection of the integrity of a subject knowledge and skills (e.g. in the e-learning materials);
- formative-axiological function that consists of philosophical and developing educational components, which are difficult to implement in the classical engineering education;
- project function that reproduces didactical elements of axiological planning of the aims of engineering education;
- predictive function that provides optimal scenario of prevision of the results of implementation of the developed above axiological functions and their components in the educational process.

We know that the reduction of classroom work leads to increase of the value and status of independent work. Moreover, its activation stimulates expansion and consolidation of the educational material, develops creativity and interactivity,

formation of practical skills including competence in the scientific literature and a variety of information resources usage. Motivated students' independent work has particular importance for formation of the technological competences during the physical experiments based on ICT systems [23].

It should be noted that competition in the labor market in the present socio-economic conditions requires professionals with new competencies. Thus, the main problem is the use of incentives based on students' understanding of the usefulness and significance of the work. Therefore, the self-learning content for the future specialists should be focused on resolving the real practical problems by means of tools of different subjects. The role of the *case-study* technology is significant for this purpose; comprehensive professionally oriented tasks allow the students demonstrate innovative approaches and thinking in addition to their academic knowledge.

There are many ways of students' motivation development: curiosity effects, puzzles can create situations of continual research and individual aims planning.

Process of teaching in the modern world is focused on competence approach that includes axiological principles: the ability to use the knowledge in social reality; agreement with social standards and ethics; social competence (responsibility, participation in-group decision-making, and conflict resolution), mental organization.

Note that psychologists and pedagogues distinguish such personality phenomena as mentality, creativity, and research ability [17]. In particular, intellect is the ability to absorb already established, existing knowledge and apply it to solve problems. The obvious is correlation between mentality and academic success of students. However, the orientation of the education system to the «average» student leads in many cases to the fact that only about half of the students increase the level of mentality during the years of university studies. As a rule, only «weak» and «average» students show positive dynamics [24].

Creativity, unlike intellectual abilities, provides creating something new by the person. The majority of researchers consider psychological creativity as relatively independent of mentality. Thus, the creativity tests use the open tasks where the number of generated solutions, a variety of the solution categories (flexibility of thinking), originality (the solution is found in less than one percentage of cases) are estimated.

As noted earlier, formation of the research approach is important for future engineers; it differs from intellectual abilities and creativity. Research approach urges the engineer to explore a new object or phenomenon in the absence of clear formulation of the problem and its solution plan.

It was found that significant psycho-emotional factor of the value-motivational sphere of the future specialists is the attitude to learning. It consists of cognitive, emotional, and activity components. These characteristics tend to sustainability for a long time after formation. The research revealed the existence of a clear link between cognitive and emotional components; therefore, technical subjects and physics teaching should cover both of them. Attitudes to the subjects study can be changed and developed, structure and content of the curriculum play great role in the development.

We consider the following types of attitude to study of the technical subjects: 1) attitude to a certain technical subject; 2) attitude to specific topics; 3) attitude to methods of a subject study; 4) attitude to learning in general. Surveys of the first-year study students prove that negative attitude to physics study, which was formed at the school, is the dominant factor that reduces the willingness of students to technical subjects study; therefore, it is the main reason why technical professions do not attract potential students.

The research also showed that physics and technical subjects become almost inaccessible for adequate understanding in many cases already at school (note: it occurs usually because of scientific data overloading). There is a risk that this learning model is applied to the basic and special subjects at the technical universities. Therefore, students reduce study to a simple rote-learning; it produces a negative attitude to the subjects.

Currently, many researchers are focused on methods of presentation of scientific information and reorganization of semantic scientific categories. Their results indicate clear progress in the students' academic success provided the transfer of emphasis in the subject content to conceptualization and personalization. The modern alternative theories of physics and technical subjects teaching are focused on conceptual restructuring the curriculum. Basic idea is that the university education should offer to students fundamental ideas, knowledge how to use the information, and where to find the missing data for successful professional activity [22].

We consider that the basic moral principles and creative values of the person can be formed during physics and technical subjects study. They are based on the understanding that future engineers have to be focused on improve of existing and research of innovative technical and technological solutions. The engineer creates a new artificial reality. The basis of the future engineer creative activity is discovery, rationalization, invention of new techniques and technologies for the prosperity of the humankind.

The fundamental moral principles, norms, and values are presented in professional codes. They consist of certain standards of behavior where interests of people who use the results of the engineering are expressed. The codes contribute to the maintenance of moral prestige and reputation of professionals in society, form credibility, and provide satisfactory moral conditions for members of the professional community. The codes good example is «The Society's Code of Ethics of civil engineers» [25].

Our research showed that moral values of future engineers begin to form at the first year study. They include the following: honesty (exclusion of careless work); teamwork; effectiveness of technical and technological activities leading to increased productivity; persistence in introducing new scientific ideas at the level of engineering solutions; impartiality, humanism; ergonomics of technical solutions; care of the safety. Modern engineers have to focus on constant study, enrichment of knowledge, computer culture, search economically competent, scientifically based technical solutions using all potentialities of fundamental and applied sciences. Uncreative work is immoral for the real engineer.

5. Conclusions

The research of leading ideas and trends in modern education has revealed a basic role of axiology. Process of rethinking and developing the educational content is determined by modern self-identity value. It is established that the value-motivational sphere of the future engineers is not a result of «teaching»; it is formed and developed through a systematic integration of modern pedagogical approaches and technologies in the education process. The most effective educational tools stimulate learning process on a personal level. Interactive teaching methods that provide interaction of students between themselves are of particular importance; there are problem-searching method, role-playing, discussions, and projects etc.

Modern education is developing on the principle of dominance of humanism over technocracy; therefore, the values theory acquires great significance. A new phase of interaction between social, scientific, and technical realities determines increasing role of human categories, awareness of the value and uniqueness of every person life. For that reason, innovative methodologies of physics and fundamental subjects teaching require the use of integrated interdisciplinary approaches based on general philosophical, sociological, and axiological principles. The research also has revealed that humanitarian correction and axiological orientation of engineering education should be considered from professional, methodological, ideological, social, and humanistic points of view.

Further researches of axiological principles application for the future engineers study can cover a wide range of issues: pedagogical approaches to the development of self-motivation in conditions of dominance of self-education on classical education; practice oriented curricula construction of physics and mathematics cycle subjects at secondary school and higher education (e.g. STEM technology); conceptual methods of fundamental subjects study.

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Аксіологічні засади навчання майбутніх інженерів фізики і технічних дисциплін

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Постановка проблеми: Формування і розвиток ціннісних орієнтацій особистості покладено в основу виховання молоді на всіх освітніх рівнях. Необхідність аксіологізації процесу підготовки майбутніх інженерів підсилюється специфікою техніко-технологічної діяльності в умовах широкого впровадження ІКТ. Інтеграція ціннісно-мотиваційних чинників з навчанням фізики і технічних дисциплін є актуальним аспектом у розбудові сучасної вищої технічної освіти. **Методи:** У дослідженні використано концептуально-порівняльний аналіз психолого-педагогічної та методичної літератури, новаторського досвіду й узагальнення власного багаторічного досвіду педагогічної діяльності, а також спостереження, бесіди з викладачами і студентами вищих навчальних закладів. **Результати:** Шляхом конкретизації функцій з'ясовано сутність аксіологізації у системі вищої освіти. Встановлено важливість перенесення мотивів навчальної діяльності з кінцевого результату на її процес і визначальну роль мотивів самоосвіти. Досліджено взаємозв'язки між ступенем ціннісно-мотиваційного розвитку особистості та її індивідуальними характеристиками. З'ясовано сутність феномену ставлення до навчання, визначено його види. Конкретизовано місце і значення у проведеному дослідженні основоположних професійно значущих морально-етичних принципів. **Висновки:** Аксіологізація вищої технічної освіти є потужним засобом формування соціально-особистісної, предметної і професійної компетентності майбутнього інженера. Створення відповідних особистісно орієнтованих дидактичних засобів ґрунтується на міждисциплінарних методичних підходах у вищій освіті.

Ключові слова: Аксиологізація освіти; майбутні інженери; самостійна робота студентів; предметна мотивація; технічна освіта; ціннісні орієнтації.

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Постановка проблемы: Формирование и развитие ценностных ориентаций личности лежит в основе воспитания молодежи на всех образовательных уровнях. Необходимость аксиологизации процесса подготовки будущих инженеров усиливается спецификой технико-технологической деятельности в условиях широкого внедрения ИКТ. Интеграция ценностно-мотивационных факторов с обучением физики и технических дисциплин является актуальным аспектом в развитии современного высшего технического образования. **Методы:** В исследовании использованы концептуально-сравнительный анализ психолого-педагогической и методической литературы, новаторского опыта и обобщения собственного многолетнего опыта педагогической деятельности, а также наблюдение, беседы с преподавателями и студентами высших учебных заведений. **Результаты:** Путем конкретизации функций выяснено сущность аксиологизации в системе высшего образования. Установлено важность переноса мотивов учебной деятельности с конечного результата на ее процесс и определяющую роль мотивов самообразования. Исследованы взаимосвязи между степенью ценностно-мотивационного развития личности и ее индивидуальными характеристиками. Выяснено сущность феномена отношения к учебе, определены его виды. Конкретизированы место и значение в проведенном исследовании основных профессионально значимых морально-этических принципов. **Выводы:** Аксиологизация высшего технического образования является мощным средством формирования социально-личностной, предметной и профессиональной компетентности будущего инженера. Создание соответствующих личностно ориентированных дидактических средств основывается на междисциплинарных методических подходах в высшем образовании.

Ключевые слова: Аксиологизации образования; будущие инженеры; самостоятельная работа студентов; предметная мотивация; техническое образование; ценностные ориентации.

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