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Education contents fundamentalization as mode of the students' professional competence development

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Abstract. Ukrainian higher education goes through the period of active transformations. At present higher education in particular in the sphere of exact sciences is no longer strictly specialized; it is changing into the mechanism of development of wide range of knowledge and skills. Competence approach becomes one of the guiding principles of its modernization for the Ukrainian system of higher education. The fundamentalization of education is able to provide creative self-realization in educational and cognitive activity and eventually in the professional one as well. The state-of-art theoretical aspects of Physics education content fundamentalization in Ukrainian higher education institutions have been analyzed. The idea of the exposure of general crucial methodological approaches and their representation in each natural subject has been analyzed. The conceptual questions of education and students' scientific activity integration as a way of professional competence development have been considered. The correlation between students' performance level and level of professional motivation competence has been analyzed.

Keywords: fundamentalization, educational paradigm, content of education, professional competence.

Introduction. The modern tendencies of society development are in need of education system reform. Innovation education system has to develop a wide range of knowledge and skills such as the strategic vision of future professional life, responsibility for own activity, self-reliance and confidence in acquired practical experience. Modern education should focus on the requirements of personality as well as the formation of erudition, professional capacity, the development of creative potential and culture. At present higher education is no longer strictly specialized; it is changing into the mechanism of general culture formation. Considering the uniform image of a graduate the state-of-art scientific conceptions define the following aims: graduates must be able to creative self-realization not only in the case of normal stable day-to-day life but also during the changing conditions of professional activity; they must have the skills of social mobility, strategic planning of the professional career, ethical responsibility etc. Such needs are defined through combined analysis of the current state of Ukrainian physical education system and job market needs. Physics graduates should be able to adapt to variable social, economic and technological conditions like mature professionals.

Drastic reevaluation of the higher education grants to it a status of the most important strategic resource. In such context the searching of new educational paradigm becomes the necessary strategy of higher education development. The new paradigm is considered as the path of crisis overcoming and the security of civilized status state progress. Ukrainian education should meet time challenges in a full, quick and accurate way for developing a personality which is able to live and operate efficiently in global environment [1].

The study of recent researches and publications shows that education problems go beyond national issues; and such observation leads to looking for educational strategies in worldwide dimension. Besides, it makes possible to develop educational area on the basis of principles of internationalization, society integration, cultural convergence, generality of aims and spiritual values. The Bologna Process [2] is the example of strategy mentioned above. Such model becomes dominant for all-European educational area.

Practically-oriented conception of the Bologna Model is based on competency paradigm, focus on result; the cri-

teria, standards and principles of education quality improvement for all-European educational area. It is important to note that the Bologna Process being the tool of strategic progress initiates a multilevel structure of higher school and raises the mobility of lecturers and students on all-European level. Besides, the conceptual and methodological aspects of education quality have been developed. Bologna Process determines the modernization of financial and economic mechanisms and stimulates the integration of science and education. The implementation of Bologna strategies enables the development of mutually acceptable methodologies, methods and techniques both on international and national levels. It creates a platform for the adoption of new educational paradigm.

Background of Study. The study is focused on the theoretical aspects analysis of content fundamentalization of education in Physics in Ukrainian higher school. The analysis of Physics place in the system of Natural Sciences has been realized. The conceptual and methodological aspects of education and students' scientific activity integration have been proposed. The level of Physics and Mathematics students' motivation competence has been determined and analyzed.

Brief History of Educational Paradigm Development. Since we take the prospective transition of Ukrainian higher education to competency educational paradigm for granted, we consider it necessary to analyze available education paradigms briefly in order find unifying aspects in the strategy of higher education development.

For the first time the term "scientific paradigm" was introduced by American philosopher of science Thomas Kuhn more than fifty years ago. The term was proposed to be used for "... universally recognized scientific achievements that, for a time, provide model problems and solutions for a community of researchers" [3].

Besides, the term "paradigm" is used in methodology in educational research; it can also be referred to knowledge about the structure of educational process accepted as objective fact by pedagogical community [4-6].

There is a whole number of paradigms, for example, dogmatic, esoteric, and technocratic which have been admitted as unpromising. At the same time modern pedagogy has considered such paradigms like behaviorism, cognitivism, constructivism, humanism, design-based paradigm, synergetic and competence ones which de-

scribe the separate aspects of higher education and correlate with other paradigms [7, 8].

Interrelations between different paradigms deal with numerous different aspects of pedagogical activity. The humanistic paradigm meets most requirements of modern society, namely the general cultural picture of the world, as well as biological, social and humanistic nature of a person. Such definition reflects the main issues of education humanization and specifies the conception of humanistic paradigm. The humanistic paradigm was created as opposition to technocratic one. Now the inadequacy of technocratic paradigm is universally recognized. Humanistic paradigm went beyond partial approach in evolution process following the civilization progress. Nowadays most researchers consider humanistic paradigm to develop into the universal approach of modern education. Such approach is the important conception of higher education pedagogy and philosophy of education. On the other hand, the paradigmatic analysis of present approaches shows that humanistic orientation can not be the prerogative of separate conceptions.

Synergetic approach develops the concept of "open education" [9]. It should be noted that the term "open education" has various interpretations. In the theory of pedagogy such term is considered as high educational standard which is also recognized by a society with the help of public authority so that the democratic principles of accessibility, equality of possibilities and independence during the syllabus development, and high quality of education are provided. Synergetic approach provides wider point of view and fundamentally new conceptual and methodological foundations of education based on the integration of all methods of world understanding.

Therefore, traditional scientific approach does not focus on the study of the separate subjects. It works with combined aspects of world-view and semantic models. This approach supports the inclusion of synergetic views to the process of design and using different kinds of information systems as well as the personality orientation of education process, changing teachers' role in open changeable world. The synergetic paradigm of fundamental education is based on the process of non-linear interaction of a future professional with intellectual environment. During such interaction a person perceives the environment as the source of improvement of individual inner world. Respectively, a person develops as an expert and obtains a possibility to improve this environment.

Paradigmatic analysis shows that competence paradigm has not a strictly defined place in the typological description of educational paradigms. However, the competence approach is the leading conception of modern educational strategy. Such educational paradigm transforms into the conceptual framework of educational national and all-European policy. Competence approach becomes one of the guiding principles of its modernization for the Ukrainian system of higher education [10]. Such approach is used while developing new generation of state educational standards [11-14].

According to reasons mentioned above it can be noted that the development of competence paradigm needs the intensification of transition from structural and instrumental innovations to conceptual and methodological grounds. The dialogue of mentalities and specific charac-

ter of educational traditions is most important and complex problem in the development of Ukrainian higher education strategy.

The term "competence" is important in the frame of our investigation. J. Raven [15] defines "competence" as individual specific ability to effective activity in the concrete subject area. Such ability is stipulating the following qualities, features and skills as highly specialized knowledge, professional skills, personal skills (methods of thinking), and responsibility. Specific activity (not the abstract) is the integral condition of competence formation, development and demonstration.

So, we can consider competence as the ability to certain activity. Such position agrees with the following statement that competence is defined as the ability to perform professional duties according to a defined standard in working environments. A professional must possess the necessary professional knowledge, skills, values, ethics, and attitudes to demonstrate competence. In Tuning project, the description of competences embraces three strands, 'knowing and understanding' (theoretical knowledge of an academic field, the capacity to know and to understand), 'knowing how to act' (practical and operational application of knowledge to certain situations), 'knowing how to be' (values as an integral element of the way of perceiving and living with others and in a social context [16].

So, competence is developed by the use of activity. We can find a lot of examples where well prepared graduates had some problems with the optimal implementation of acquired professional knowledge in the specific production and management situations. It is obvious according to such point of view that a competent expert must have not only fundamental theoretical groundings but also practical training and creative ones with understanding the importance of their work. Thereby, competence is the modern unit of measurement of educated person. It is the result of education which is expressed in the specific methods of activity acquirement; besides, competence is the synthesis of cognitive, practical and personal experience. The level of education can be described in the terms of individual self-development level.

The fundamentalization of education being the unifying factor for the considered educational paradigms has to provide requisite and sufficient conditions of the evolutionary development of the methodological and cultural foundation of students' personality. Such approach is able to provide creative self-realization in educational and cognitive activity and eventually in the professional one as well. It can guarantee the quality of future specialists' professional activity.

The methodological, intellectual, information and creative cultures are the main components of the methodological and cultural foundation of a personality.

Theoretical Basis of Education Fundamentalization. Education has to be fundamental. It means that it has to be deep and detailed. The acceptance of fundamentalization process is caused by the critical increasing of information content and stable tendency to its update over the period of two-three years. Fundamentalization is accepted as leading tendency in many countries which took into account the Memorandum of International UNESCO Symposium "Fundamental (Natural and Humanitarian) Uni-

versity Education" [17]. Now the development of modern educational strategies is partially based on the main proposition declared in this memorandum. Particularly, the aims connected with the acquisition of fundamental interdisciplinary knowledge, more stable and versatile, have become cardinal.

We can highlight the following top-priority goals of educational strategy development:

- Implementation of the cycle of general humanitarian subjects in natural and technical education to overcome the separation of natural and humanitarian components of a personality's integral world-view culture

- Creation of integrated interdisciplinary courses containing the most versatile and generalized knowledge which are the basis of applied investigations and developments as well as general and professional culture of a personality, the skills of fast adaptation to the new requests and the conditions of activity

- Overcoming contradictions between fundamental education and vocational training

Education is considered to be focused the interest of personal development if the following aims are satisfied [18]:

- Development of prerequisites and conditions for continuous education and self-education

- Formation of practical ability to work with lots of information under the condition of its continuous change and increase

- Stimulation of intellectual development and improvement of thinking by learning modern methods of scientific cognition

- Harmonization of relationships between human and nature by learning modern scientific picture of the world

- Successful socialization of a personality by taking into account the environment, namely its cultural, anthropogenic and computerized aspects

- Creation of conditions for wide and fundamental education which is necessary for the prompt change in the different types of professional activity. Such aim takes into account the integrative tendencies of science and education development.

The conception of three-level system is proposed while analyzing the problem of fundamental education integrity. The first (highest) level means the integrity of the whole fundamental education as the main body and the ultimate aim of new educational paradigm. At the same time it should be noted that the establishment of education integrity is impossible without the successful solution of narrower tasks to provide the integrity on the second and third levels. Developed approaches to the solution of such a problem can be considered as an example of the integrity of fundamental technical education (the second level) and the integrity of its separate courses components (the third level). The second level in the case of natural education is considered to be reached if the general natural subjects being the required part of the curriculum create a uniform system. Such system is not a simple set of traditional courses. It has a uniform aim, the object of research, the methodology of structure and focuses on interdisciplinary relationships.

Thus, curriculum formation has to be based on the integral cycle conception of natural subjects. The topicality and significance of this conception lies in the fact that ac-

ording to new educational paradigm the generalized integrated view of nature has to be created during students' training. The main didactic aspect of the cycle integrity of natural subjects (physics, chemistry, biology) is the community of methodological directives during curriculum development considering the necessity of rational scientific thinking and general culture formation. The real development of generalized natural courses cycle represents the unity of opposites in interconnections between natural sciences. In fact, the evident differentiation remains in the past. Nowadays, the most promising researchers are those on the verge of some natural sciences (for example biology and chemistry, biology and physics).

The natural sciences are starting to play a leading role in the modern science. It is the separate interdisciplinary branch of scientific knowledge which has its own subject and methods of investigation integrating independent natural studies. However, it doesn't mean that natural science takes up these sciences. Now it is in the process of crystallization of its own fundamental paradigms, which are associated with the global ideas of dynamic chaos open systems functioning as well as the self-organization and evolution of living and inanimate systems. Such theory can be considered as a platform for new modified natural science.

Such conception is based on the idea of the exposure of general crucial methodological approaches and their representation in each natural subject. It can be considered as an alternative to traditional education for which it was enough to determine local interdisciplinary relationships. The objective methodological laws of natural studies development, changing the types of scientific rationality and general views of nature interrelations and its subject, the problem of scientific knowledge objective character, the recognition of nature and human unity, the necessities of integral natural and scientific culture formation and the development of reasonable natural and scientific thinking are the main modern methodological approaches.

The integral natural and scientific picture of the world is the expected result of education according to such conception. The acquisition of modern scientific rationality which uses the various strategies of cognitive activity is necessary condition. It is known that there are classical and non-classical versions of scientific picture. Modern sciences give its different interpretation. However, natural education has a possibility to form integral thinking by the implementation of classical and non-classical versions of scientific views. It is the most difficult problem of education fundamentalization.

It is caused by considerable difficulties connected with insufficient mutual understanding between the representatives of various natural sciences. The integrated methodological approaches to different subject instruction are not developed. At the same time the objective necessity of new educational paradigm realization requires efforts to develop such approaches and to find understanding between scientists. The active operation in this direction leads to higher level of education fundamentalization in general.

The third level (separate natural subject) is very urgent. We consider Physics education as an example. Physics is the fundamental basis of natural science cycle. In addition Physics plays the role of basic science inside such a cycle;

and Physics can be considered as a self-sufficient science branch on the level of an independent subject. According to the conception analyzed above it seems irrational to dissipate Physics into practically autonomous chapters in the way that the succession of these chapters can be changed randomly. The integrity on the level of a separate subject provides the internal logic to obey to subject content. It corresponds to modern scientific views. We propose to support the integrity on the level of a separate subject by the development of prevailing physical fundamental models which are appropriate to the integrity of Physics reality and essential unity of nature.

Probably, it is the principle of education fundamentalization in modern sense. There is the problem of fundamental axis formation in natural subjects instead of searching fundamental cores in separate natural subjects. Such formation takes place under the influence of technical science fundamental ideas which form the basis of wide professional thinking. The fundamental axis has to take into account the natural and scientific principles and fundamental laws on which technical knowledge is based.

The rate of modern life is very high. So, the valid content of education can't satisfy the requests of a society, social groups and an individual. It is isolated from real life and contains a lot of outdated information. Such information can't be useful for a future professional and can't assist in his training.

The analysis of the valid state standards of general secondary education and higher professional education indicates the partial or complete failure of subject oriented approach. The modernization of education content is reduced to the extraction/addition of separate topics from/to the list of investigated ones under such approach. There are no radical changes of the subject content during the development of new standards. Therefore, there is a gap between self-knowledge problems and personality self-determination advancement on the foreground and the absence of special tools in education content.

Modern didactics considers education content as the set of different types of reviewed cultural experience. The development of this content provides the pupils and students with preparedness to the discharge of social, professional and other functions. Education is the part of social experience which is introduced into the educational sphere in order to its mastering by the next generation according to the content [19]. So, future specialists obtain a possibility to produce special internal meaning which has the character of a personality. It can be formed like any other object. But the education content can take different forms during its concretization. It can be presented by syllabus in one case. Besides, it can be a part of textbooks and manuals. And, of course, education content functions in the interconnected scientific and research activity of lecturers and students.

Exactly in the terms of educational process activation the last characteristic of education content gives an opportunity to pass from the information function of teaching to managerial, adjustment and consultative ones with personality oriented bias. Thus, students' creative potential can be exposed; natural and scientific competence as the main part of future specialists' professional competence can be formed during the fundamentalization of education. The development of professionals' natural and scien-

tific competence improves their competitiveness on labour market.

Practical aims of education fundamentalization and ways of its achievement. The training of future specialist to perform their professional duties is a complex multifaceted problem. Its successful solution depends on coordinated professional training. Now Ukrainian higher education goes through transformation to two level system, development and statement of State Standards of higher education, using innovation educational technologies [20].

The problem of Physics students' professional competence formation demands a versatile investigation as well as the new paradigm of educational research. We concentrate on the problem of professional competences during the fundamental subjects study. Direct changing of Physical and Mathematics specialities syllabus relates to the need of correlation the credits of fundamental training of Ukrainian students with European ones. On the other hand, we should define the term "professional competencies" of future specialists and its position in the model of professional competence.

The formation process of graduates' professional competencies in Physics and Mathematics can be realized by changing both its curriculum and techniques of teaching. It's important to develop a conscientious attitude to future profession, inclination for it, and tendency to acquire knowledge of high quality and using it in real situations. The skill to work with scientific information, tendency to in-depth study of certain themes, the attainment of communication during project activity are also very significant.

Nowadays, the idea of "competence formula" needs a deep investigation caused by the necessity of "competence", "competency", "professional competencies" term definition as well as the ways of their implementation in education process. It is related to frequent intuitive using such terms in practice.

The research shows that the methodological basis of competence and activity approach comprises the following positions:

1. The construction of practically oriented learning in the system of natural education; the comprehension of education aims has to be based on the formation of activity modes which provide the realization of professional duties.
2. The education content is defined by using the specified system of future professional activity and knowledge provided the realization of this activity.
3. The professional activity (not knowledge) is of primary importance during education process planning and organization.
4. Knowledge isn't self-sufficient; it is a tool of the instruction and realization of certain activity.
5. Students study by using the models of future professional activity rather than focus on knowledge accumulation.
6. The solution of problems is the main mechanism of study.
7. Now learning something means the competent realization of certain activity.
8. Using knowledge is the main way to acquire it.

Activity becomes an internal condition of a personality movement to his aim in the system of Physics and Mathematics education experience. It becomes the criteria of students' preparedness to independent and successful professional activity.

The depth of students' interest to their future activity is the important part of professional competence. The level of Physics and Mathematics students' motivational competence was determined. 74 first- and fourth-year students picked randomly were interviewed.

The set of the following students' characteristics as the motivation of future profession choice, understanding of professional environment, notions about profession and social purposes gives a possibility to identify different types of students' relation to the level of professional orientation.

The first group includes students with positive professional orientation which is maintained during all the time of their study. The orientation in professional environment is connected with the attractiveness of profession and high public importance. The high level of their activity was observed.

The second group involves students for which the choice of their profession doesn't have highly defined professional motivation. They don't have enough information about future profession and fixed attitude to it. The activity is characterised by instability.

The students with the negative attitude to their future profession belong to the third group. The choice motivation of their future profession is caused by the general prestige of higher education. The low level of their activity was observed.

Besides, their attitude to scientific activity was determined. Also, three groups of students were defined according to the results.

The first group includes students with positive attitude to research activities; such students want to work in research projects and recognize the prospects of their future profession. The second group involves students with neutral attitude. Such students can work as scientists but they are passive and need continuous support. The third group includes students with negative attitude. The following diagrams were created according to obtained results. The analysis of obtained results indicates the correlation between the progress level and attitude to scientific activity. Students with high progress level and positive professional orientation have a positive attitude to research activities and vice versa. Involvement of students with low progress level to the simple but original research problems with due account taken of students' peculiarities can help to better understand the specific of their future professional activity.

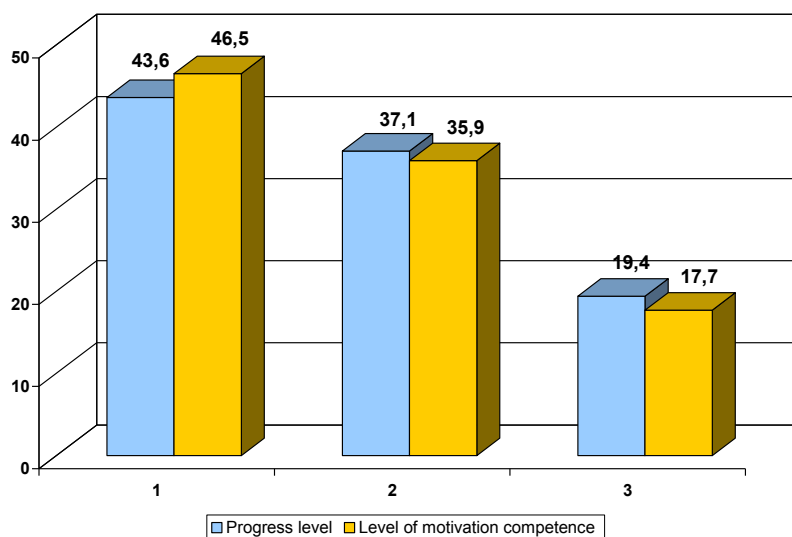


Fig. 1. Comparative Characteristics of Motivation Competence Level and Progress Level Rate for Physics and Mathematics Students

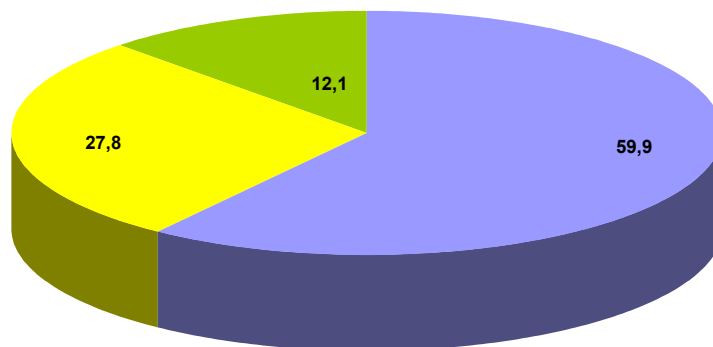


Fig. 2. Students Attitude to Scientific Activity

Conclusion. The correlation between the level of motivation competence, progress level and attitude to scientific activity was observed. Thus the training of Physics and Mathematics Students to the creative professional activity is closely connected with involvement of students to the investigation activity. The following conditions have to be satisfied. System of undergraduate research work must be connected both with theory and practical studies; the individual students' peculiarities must be taken into account on all stages of research activity. Also the proposed topics of investigation work have to taking into account students' curriculum.

The concretization of Physics education content focused on scientific and research activity stimulates students to independent thinking and searching problem solution during their education process. It broadens future professionals' outlook both in their own specialization and in adjacent branches.

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REFERENCES

1. Kremen, V.G. (2009). *White paper of the Ukrainian national education*. Kyiv: Ukrainian Academy of Pedagogical Science.
2. European Higher Education Area in 2012: Bologna Process Implementation Report. (2012) Education, Audiovisual and Culture Executive Agency, [http://www.ehea.info/Uploads/\(1\)/Bologna%20Process%20Implementation%20Report.pdf](http://www.ehea.info/Uploads/(1)/Bologna%20Process%20Implementation%20Report.pdf).
3. Kuhn, Thomas S. (1996). *The Structure of Scientific Revolutions (3rd ed.)*. University of Chicago Press.
4. Popkewitz, Thomas S. (1984). *Paradigm and Ideology on Educational Research: Social functions of the intellectual*. London: Falmer Press.
5. Niglas, K. (2001) Paradigms and Methodology in Educational Research. Paper given at ECER2001, Lille, 5–8 September 2001 <http://www.leeds.ac.uk/educol/documents/00001840.htm>.
6. Guba, E. G. & Lincoln, Y. S. (1994). *Competing Paradigms in Qualitative Research*. In Denzin, N. K. & Lincoln, Y. S. (eds.) *Handbook of Qualitative Research*. London: Sage, pp. 105–117.
7. Dills, Charles R. & Romiszowski Alexandr J. (1997). *Instructional development paradigms*. Educational Technology Publications Inc.
8. Reiser, Robert A. & Dempsey, John V. (2012). *Trends and Issues in Instructional Design and Technology*. Pearson Books.
9. Steklova, I. (2004). Synergetics in Science and Education. *Russian Education & Society*. 46 (2), 82–88.
10. Ovcharuk, O.V. (2004). *Competence approach in modern education. World experience and Ukrainian outlooks*. Kyiv: K.I.S.
11. Sloane, P. & Dilger, B. (2005). The competence clash – dilemmata bei der Übertragung des 'konzepts der nationalen bildungsstandards' auf die berufliche bildung. In: Berufs- und Wirtschaftspädagogik Online, No 8. http://www.bwpat.de/ausgabe8/sloane_dilger_bwpat8.pdf.
12. Erpenbeck, J. (2006). Metakompetenzen und Selbstorganisation. In Erpenbeck, J., Scharnhorst, A., Eberling W. et al. *Metakompetenzen und kompetenzentwicklung*. (pp. 5-14). <http://www.abwf.de/content/main/publik/report/2006/report-095-teil1.pdf>.
13. Bergmann, G., Daub, J., Meurer, G. (2006). Metakompetenzen und Kompetenzentwicklung in systemisch-relationaler sichtsicht Selbstorganisationsmodelle und die wirklichkeit von organisationen. <http://www.abwf.de/content/main/publik/report/2006/report-095-teil2.pdf>.
14. Gnahn, D. (2007). *Kompetenzen – erwerb, erfassung, instrumente*. Bielefeld: Bertelsmann.
15. Raven, J., Stephenson, J. (2001). *Competence in the Learning Society*. New York: Peter Lang Publishing.
16. Bologna Working Group on Qualifications Frameworks. (2005). A Framework for Qualifications of the European Higher Education Area. http://www.bologna-bergen2005.no/Docs/00-Main_doc/050218_QF_EHEA.pdf.
17. Memorandum of UNESCO International symposium, (1994). *Higher Education in Russia*, 4, 4-6.
18. Sukhanov, A. D. (1996). Conceptions of fundamentalization of higher education and its reflection in State Educational Standards. *Higher Education in Russia*, 3, 36-44.
19. Uman, A.I. (2007). Formation of the education content and pedagogical reality. *Innovations in education*. 1 (4 – 10).
20. Nychkalo, N.G. et al. (2002). *State Standards of Professional Education: Theory and Technology*. Khmelnytsky: TUP.

Луценко Г.В. Фундаментализация содержания образования как способ формирования профессиональной компетентности студентов

Аннотация. Украинское высшее образование проходит период активной трансформации. Сейчас высшее образование в сфере точных наук не является строго специализированным, оно преобразуется в механизм формирования широкого диапазона знаний и умений. Компетентностный подход становится одним из руководящих принципов модернизации украинской системы высшего образования. Фундаментализация образования позволяет обеспечить творческую самореализацию в образовательной, познавательной и профессиональной деятельности. В статье анализируются современные теоретические аспекты фундаментализации содержания физического образования в украинской высшей школе, а также идея выделения общих ключевых методологических подходов и их использования для системы естественных наук. Рассматриваются концептуальные вопросы интеграции образования и студенческой научной деятельности как способа развития профессиональной компетентности, корреляция между успеваемостью и уровнем профессиональной мотивационной компетентности.

Ключевые слова: фундаментализация, образовательная парадигма, содержание образования, профессиональная компетентность.