

Biletska H. A.

CRITERIA, INDICATORS, AND LEVELS OF NATURAL SCIENCE COMPETENCE OF PROSPECTIVE ECOLOGISTS

The search for the ways of bringing the goals, content, and outcomes of education closer to the needs of the development of society focused the attention of educators on competence and core competencies. The best practices of developing and implementing competency-based approach into education offered by foreign scholars have been of importance in this regard; at the same time, national educators have attempted to adjust these practices to the conditions and specifics of the Ukrainian education. Furthermore, they offered their own theoretical and practical experience in the study of the competence and the implementation of the competency-based approach.

Problems of the competency-based education and the formation of competencies were the objects of study of many scholars, such as: N. M. Bibik, V. O. Bolotova, I. A. Zimniaia, Ye. F. Zeier, V. V. Kraievskiyi, O. I. Lokshina, O. V. Ovcharuk, L. I. Parashchenko, V. A. Petruk, T. A. Petuchova, O. I. Pometun, S. A. Rakov, O. Ya. Savchenko, Yu. H. Tatur, et al. Another important aspect of these studies is the measurement of the level of the formation of competence. Criteria, indicators, and levels of training were studied by Yu. V. Babanskyi, V. N. Bahriy, O. V. Barabanshchikov, V. P. Bepalko, N. V. Kuzmina, Ye. M. Lugovska, A. K. Markova, O. M. Novikov, et al. At the same time, the analysis of the existing research indicates that modern national pedagogy has yet to address the theoretical and practical aspects of competency-based approach to teaching natural sciences, the formation of natural science competence in prospective ecologists, and the definition of the criteria, indicators, and levels of its formation.

The purpose of the article is to provide the definition of and substantiate the basic criteria, indicators, and levels of the formation of the natural science competence of future ecologists.

In the system of higher environmental education, sciences occupy a prominent place. They are the basis of professional and practical disciplines and lay the foundation of the future profession. It influences the formation of professional skills of future professionals, as well as the level of their mobility, their competitiveness and value at the labor market. Moreover, it contributes to students' natural science worldview, which is an integral part of human culture, forms the idea of the world around, of their role and place in this world, introduces the methods of scientific cognition and provides a basis for research. The result of teaching/learning science is the natural science competence – an integral characteristic of the qualities of environmental experts reflecting their level of knowledge in the fundamental natural science, natural science worldview, environmental values, and experience in academic and practical activities that are sufficient to carry out professional duties [1, p. 34].

The competence is built by the formation of its components. The analysis of scientific and pedagogical works dedicated to the research of competence and its structural elements by V. O. Adolf, N. H. Vitkovska, H. O. Paputkova, O. A. Cheremysina, B. O. Shevel, V. V. Yahupov, et al. allowed us to emphasize the following components of natural science competence:

- cognition – a set of knowledge that contributes to the natural science competence of environmental specialists with the projection for future professional activities;

- practical activity – a set of skills to use natural sciences for the practical solution of professional tasks;

- motivation – a set of motives that encourage students to study natural sciences, attitude towards them as essential for further professional training and practical activity; motives that encourage the environmental activities;

– personality – a set of individual psychological traits and abilities, important both for the future ecologist and for modern specialist in general.

To measure the formation of competence, certain criteria are used. In encyclopedias, the notion of a “criterion” (Greek “kritĕrion” – a standard, equivalent) is interpreted as a rule or principle for evaluating or testing something; a standard to identify, evaluate an object or phenomenon [2, p. 149]; the basis for the evaluation or classification of something [3, p. 211].

In pedagogy, criteria involve the features by which one can evaluate and compare educational phenomena, processes, etc. A. V. Halimov notes that the criterion expresses the most common essential feature, regarding which the assessment, comparison of the real-life educational phenomena are done. Furthermore, the degree of manifestation, the formation in terms of quality, the definiteness of the criterion are determined in specific terms, which, in turn, are characterized by several features [4, p. 93].

According to O. M. Novikov, criteria must meet a number of requirements. In particular, they should be objective (to the degree possible in pedagogy), allow certain definiteness when evaluating the studied phenomena; be adequate, valid, i.e. to assess exactly what the researcher wants to assess; neutral relatively the studied phenomena; a set of criteria must adequately cover all the essential characteristics of the studied phenomenon and process [5, p. 142 – 143]. S. V. Ivanova notes that criteria should also reflect the dynamics of the measured quality in space and time and unfold through indicators. Basing on the intensity of manifestation, one can make conclusions about the level of the formation of certain criteria [6, p. 153].

In terms of the components of natural science competence of future ecologists, we shall talk about the following criteria of its formation: cognitive, motivational, of practical activity and personality. Each criterion expresses the highest level of the phenomenon and is an ideal model for comparison with concrete events; it can be used to measure the concordance of the existing level of competence [4, p. 93].

The cognitive criterion allows the evaluation of the knowledge in natural sciences. The criterion of practical activity makes it possible to determine the skills

and abilities to use the natural science knowledge to solve professional tasks and the capacity for independent study. By means of the motivational criterion, one can measure the motives for studying natural science disciplines, for professional environmental activity, and environmentally responsible behavior. The criterion of personality can determine individual psychological qualities and abilities, important for professional environmental activity.

Indicators characterize a state or a level of the development of the object being studied in terms of the selected criterion. According to V. I. Ternopil'ska and O. V. Derevianko, indicators are quantitative or qualitative characteristics of the formation of the quality, property, or feature of the object under study, a degree of the formation of a criterion [7, p. 265]. V. N. Bagriy interprets indicators as individual qualitative and quantitative features of a criterion and argues that, when determining the indicators of pedagogical activity, one should adhere to the following requirements: definiteness of the content of indicators, measurability of indicators; systemic nature of indicators, which should ensure the most complete characterization of the process under study; flexibility; adaptability; the ability to express all possible changes of the object; and the effectiveness and efficiency of indicators [8, p. 10].

For each criterion of the natural science competence of future ecologist, we determined the indicators of its formation. The indicators of the cognitive criteria of the natural science competence of environmental experts include formation of the system of the natural science knowledge, strength and awareness of knowledge. The criterion of practical activity includes such indicators as skills to solve professional tasks using natural sciences and the capacity to independent study. Indicators of motivational criterion involve the formation of motives for study natural sciences, the attitude towards them; commitment to professional environmental activities; commitment to environmentally responsible behavior in any endeavor. In terms of personality criteria, we identified the following indicators: ability to interpret, predict, and evaluate own activity and its results; commitment to excellence, environmental consciousness.

The development of indicator is reflects in its level. We interpret the level as the degree of the formation of the natural science competence of future ecologists.

Scholars distinguish various levels of competence, such as narrow, sufficient, and broad levels (V. M. Vvedenskyi [9, p. 52]); initial, normative, active, creative (Ye. M. Lugovska [10]); reproductive, adaptive, local-simulating, systems-simulating, creative (Ye. M. Pavliutenkov [11, p. 77]); and reproductive, reconstructive, creative (V. I. Ternopilska, A. V. Derevianko [7, p. 265 – 266]), etc. Based on the analysis of scholarly papers that highlight the levels of competence according to certain criteria and indicators, we identified the following four levels of natural sciences competence of future ecologists: reproductive, reflective, heuristic, and creative.

According to the cognitive criterion, a future ecologist with a creative level of natural sciences competency has conscious, robust, and systemic knowledge in natural sciences; he or she is aware of scientific concepts, theories, and conceptions of natural science, which is the foundation for natural science worldview; understands the importance of natural sciences for solving professional tasks. Students studying ecology and possessing a heuristic level of natural sciences competence has a sufficient and conscious knowledge in natural sciences, can reproduce it; aims for acquiring new knowledge; and is able to use certain concepts and patterns in the professional activity. Prospective ecologists endowed with a reflective level of natural sciences competence possess a conscious science knowledge, but its level is insufficient; they are ready to acquire new knowledge; able to reproduce knowledge and partially understand the scope of its application. Typically, students-ecologists with a reproductive level of natural sciences competence have superficial, unstable, and unsystematic knowledge in natural sciences; such students have failed to master the concepts of natural sciences in full; are indifferent to new information; and are able to reproduce only certain pieces of knowledge.

Creative level of natural sciences competence of prospective ecologists, according to the practical activity criterion, requires the ability to make independent

effective decisions, develop and justify their own approaches to solving professional tasks using natural sciences, and evaluate the effectiveness of the applied approach. The actions of such students are completely conscious, their skills are formed on a creative level, and they consciously pursue independent study. Students-ecologists possessing a heuristic level of natural sciences competence are able to apply knowledge in natural science to solving professional tasks, develop and justify their own approaches to solving environmental problems. These students are capable of independent study. Future ecologists who have achieved a reflective level of natural science competence are able to use natural sciences skills. Their actions are conscious; they are able to perform routine tasks independently and make decisions, which are, however, not always grounded. Their ability for independent study is poorly developed. Students with a reproductive level of natural sciences competence can hardly apply knowledge in natural sciences to solving professional tasks; their skills and abilities are weak. The actions of such students are not exactly conscious and performed by an algorithm. They are not able to make independent decisions. There is no capacity for self-education.

According to the motivational criterion, students-ecologists with a creative level of natural sciences competence have stable motives for studying natural sciences; understand their importance for further professional training and practice. Also, students have a deep and conscious interest in their chosen career. Future ecologists with a heuristic level of natural sciences competence are motivated to master natural sciences knowledge, skills, and abilities and demonstrate the need for achievement and positive attitude towards their chosen career. Students-ecologists with a reflective level of natural sciences competence are characterized by unstable motives for studying natural sciences; their interest in natural science and future career is formal. Students with a reproductive level of natural sciences competence are not motivated to learn natural sciences; their dominating motive is avoiding failure. The motives for professional environmental activities and environmentally safe behavior are situational.

Future ecologists with a creative level of natural sciences competence, according to the personality criterion, are capable of self-control and self-evaluation, committed to self-improvement of professional and personal qualities, and possess well-developed environmental awareness. Students with a heuristic level of natural sciences competence have not fully developed the above qualities and abilities. Value orientations are developed, but environmental awareness is not formed. Future ecologists with a reflective level of natural science competence have underdeveloped qualities and abilities important for professional environmental activity. Value orientations are also poorly developed. Student-ecologists with a reproductive level of natural sciences competence have the following individual psychological qualities and abilities as self-control and self-evaluation, commitment to excellence at an early stage of formation. Value orientations are situational. Criteria, indicators, and levels of natural sciences competence of ecologists are shown in Table 1.

Table 1. Criteria, indicators, and levels of natural sciences competence of prospective ecologists

Criteria	Cognitive	Practical Activity	Motivation	Personality
Indicator	The system of knowledge in natural sciences; strength and awareness of knowledge	The ability to apply knowledge in natural sciences; ability to independent study	Motives for studying natural sciences; motives for environmental activities	The capacity for self-control and self-evaluation; striving for self-improvement; environmental awareness

Level of formation	Creative level	<p>Knowledge is sufficient for studying professional disciplines and professional activities; knowledge is conscious, robust, and systematic; natural scientific worldview is formed</p>	<p>The ability to make independent decisions, develop and justify their own approaches to solve professional tasks; skills are formed at the creative level; purposeful self-education</p>	<p>Stable motives of studying natural sciences; understanding of their importance for training and practice; deep and conscious interest in chosen career</p>	<p>The capacity for self-control and self-evaluation; pursuit of improvement of professional and personal qualities; understanding of the value of nature and environmental awareness</p>
	Heuristic level	<p>Knowledge is sufficient and conscious; striving to acquire new knowledge; ability to reproduce knowledge and understanding of their importance in professional work</p>	<p>Ability to independently develop and justify their own approaches to solving professional tasks; desire for independent study</p>	<p>Formed motives of studying natural sciences, need for achievement dominates; positive attitude toward chosen career</p>	<p>The capacity for self-control and self-evaluation is not fully formed; aim for self-improvement is quite tangible; value system is stable</p>

	Reflective level	Knowledge is conscious, but not sufficient; openness to new knowledge; ability to reproduce knowledge and partial understanding of the area of its application	The ability to use knowledge in natural sciences; independently perform routine tasks and make decisions; the ability for independent study is poorly developed	Motives for studying natural sciences are unstable; only formal interest in natural sciences and future career	The capacity for self-control and self-evaluation; self-improvement motives are poorly formed; value orientations are poorly developed
	Reproductive level	Knowledge is superficial, unstable, and unsystematic; indifference to new information; ability to reproduce certain pieces of knowledge	Failure to use natural sciences knowledge; actions are not conscious enough and performed by an algorithm; ability for independent study is missing	Motives of studying natural sciences are not formed; failure avoidance dominates; professional motives are situational	The capacity for self-control, self-evaluation, and self-improvement is not formed; value orientations are situational

The identified criteria, indicators, and levels will provide an opportunity to evaluate the natural science competence of future ecologist, which is the prospect for our future research aimed at the improvement of the effectiveness of professional environmental education.

References

- 1. Biletska H. A.** Pryrodnycho-naukova kompetentnist u strukturi profesiinoyi kompetentnosti fakhivtsia-ekoloha [Natural Sciences Competence in the Structure of the Professional Competence of Environmental Experts]. International scientific and practical conference “Methods of Teaching Natural Sciences in Secondary and Postsecondary Educational Establishments”. Poltava. May 29 – 30, 2013. Ed. Prof. M. V. Hriniova. Pp. 33 – 35. (ukr)
- 2. Kodzhaspirova G. M.** Slovar po pedahohike [Teacher's Glossary]. Moscow. *Mart*. Rostov on Don. *Mart*. 2005. 174 p. (rus)
- 3. Novyi** tlumachnyi slovnyk ukrayinskoyi movy [New Glossary of the Ukrainian Language]. Comp. V. Yaremenko. Kyiv. *Akonit*. 1998. 351 p. (ukr)
- 4. Halimov A. V.** Teoretyko-metodychni zasady pidhotovky maibutnikh ofitseriv-prykordonnykiv do vikhovnoyi roboty z osobovym skladom [Theoretical and Methodological Basis for Training Future Border Officers in Educational Work with Staff]. Khmelnytsky. *NADSPU*. 2004. 376 p.(ukr)
- 5. Novikov A. M.** Metodologiiia nauchnogo issledovaniia [Methodology of Scientific Research]. Moscow. *Librokom*. 2010. 280 p. (rus)
- 6. Ivanova S. V.** Kryteriyi ta pokaznyky rozvytku profesiinoyi kompetentnosti vchyteliv biolohiyi v zakladakh pisliadyplomnoyi pedahohichnoyi osvity [Criteria and Indicators of the Development of the Professional Competence of Teachers of Biology in Continuous Pedagogical Education Institutions]. Journal of Zhytomyr State University. 2010. Issue 52. Teaching Science. Pp. 152 – 156. (ukr)
- 7. Ternopil'ska V. I.** Viznachennia kryteriyiv sformovanosti profesiinoyi kompetentnosti maibutnikh hirnychykh inzheneriv [Determining the Criteria of Mining Engineers' Professional Competence Formation]. Collection of Research Papers of Drahomanov NPU. Series 5. Pedagogical Sciences. Issue 31. 2010. Pp. 264 – 267. (ukr)
- 8. Bahriy V. N.** Kryteriyi ta rivni sformovanosti profesiinykh umin maibutnikh sotsialnykh pedahohiv [Criteria and Levels of Professional Skills of Future Social

Pedagogues]. Collection of Research Papers of Khmelnytsky Institute of Social Technology of “Ukraine” University. No. 6. 2012. Pp. 10 – 15. (ukr)

9. Vvedenskyi V. N. Modelirovaniie professionalnoi kompetentnosti pedagoga [Modeling of the Professional Competence of Teachers]. Pedagogy. 2003. No. 10. Pp. 51 – 55. (rus)

10. Luhovska Ye. M. Kryteriyi otsiniuvannia fakhovoyi kompetentnosti tekhniv-mekhaniv ahropromyslovoho vyrobnytstva [Criteria for Evaluating Professional Competence of Mechanical Technicians of Agricultural Industry]. Retrieved from: <http://nvd.luguniv.edu.ua/archiv/NN21/13lemtav.pdf>. (ukr)

11. Pavliutenkov Ye. M. Modeliuvannia v systemi osvity (u skhemakh i tablytsyiakh) [Modeling in the Educational System (presented by Graphs and Tables)]. Kharkiv. *Osnova*. 2008. 128 p. (ukr)

Білецька Г. А. Критерії, показники й рівні сформованості природничо-наукової компетентності майбутніх екологів

У статті визначено й схарактеризовано основні критерії оцінки сформованості природничо-наукової компетентності майбутніх екологів: когнітивний, діяльнісний, мотиваційний, особистісний. Для кожного критерію встановлені й обґрунтовані показники, які його характеризують. Проаналізовані рівні сформованості показників природничо-наукової компетентності – репродуктивний, рефлексивний, евристичний, креативний. Визначені критерії, показники та рівні забезпечать можливість оцінити сформованість природничо-наукової компетентності майбутнього еколога, що буде сприяти підвищенню ефективності професійної екологічної освіти.

Ключові слова: природничо-наукова компетентність, критерій, показник, рівень сформованості компетентності.

Белецкая Г. А. Критерии, показатели и уровни сформированности естественнонаучной компетентности будущих экологов

В статье определены и охарактеризованы основные критерии естественнонаучной компетентности будущих экологов: когнитивный, деятельный, мотивационный, личностный. Для каждого критерия обоснованы показатели, которые его характеризуют. Проанализированы уровни сформированности показателей естественнонаучной компетентности будущих экологов – репродуктивный, рефлексивный, эвристический, креативный. Определенные критерии, показатели и уровни обеспечивают возможность оценить сформированность естественнонаучной компетентности будущего эколога, которая будет способствовать повышению эффективности профессионального экологического образования.

Ключевые слова: естественнонаучная компетентность, показатель, уровень сформированности компетентности.

Biletska H. A. Criteria, Indicators, and Levels of Natural Science Competence of Prospective Ecologists

The article identifies and characterizes certain basic criteria of the formation of natural science competence in prospective ecologists. These criteria belong to one of the four spheres: cognition, activity, motivation, and personality. The indicators that characterize criteria are established and justified.

The indicators of cognitive criteria constitute a system of natural science knowledge, its strength and conscious nature. Activity criteria are characterized by the indicators such as the formation of skills in solving professional goals using the natural science knowledge, the ability to self-education. The reasons to study natural sciences and motivations for the environmental activities are the indicators of motivational criteria. The following parameters are inherent to the personality criteria: self-control, self-esteem, self-improvement, and environmental consciousness.

The author establishes and characterizes the levels of the formation of natural science competence in prospective ecologists, such as reproductive, reflexive, heuristic, and creative levels. The determined criteria, indicators, and levels provide

an opportunity to assess the level of the formation of natural science competence of prospective ecologists, which will enhance the effectiveness of postsecondary environmental education.

Key words: natural science competence, criteria, indicator, the level of the formation of competence.

The article was received by the Editorial Office on 07.10.2013

The article was put into print on 28.03.2014

Peer review: Loboda S. M., Doctor of Pedagogical Sciences, Professor