

Implementation of New Approaches to Zoology and Ecology Teaching Based on the Bioecology of Snakes and Sarcosporidia Course

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Abstract

This study is devoted to one of directions in education system development – ecologization of teaching and student training, focused on practical significance of acquired knowledge and skills. The authors have analyzed how the regional component of the state educational standards has developed in various territorial entities. The paper presents the strategy of ecological education and differentiated system approach to zoology and ecology teaching based on studying bioecology of snakes and sarcosporidia. Research results showed that the differentiated system approach has significantly improved the performance and stimulated the student's desire to learn and self-develop. It is shown that the differentiated system approach is the most efficient in combination with an individual one. This combination provides the possibility to develop training programs on ecological and biological issues with regard to personal characteristics of each student and modern environmental challenges.

Keywords: ecology, education, zoology, new approach

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INTRODUCTION

Today, human civilization is characterized by the increased development of information component. The world of ecological problems did not become clear, students did not manage to learn them better and faster (Shilova and Sibgatullina 2017, Stukalenko et al. 2016). Huge positive and negative teaching experience determines the importance of further reforms in secondary and higher education. At the same time, global challenges should not interchange some methodological problems related to ecology and biology teaching (Shchukina 1990). Scott (2009) outlines the incorporation into environmental education of notions of sustainable development, a “linked human-environment” concept that describes a process of making the emergent future ecologically sound and humanly habitable, as it emerges, through the continuous responsive learning which is the human species most characteristic endowment”.

Presently, teachers face up to the task of organizing learning that will allow students to understand the importance of relevant new knowledge, and, more importantly, to deliberately gain this knowledge as a basis for their individual development. These issues are topical for many countries, which representatives consider the emerging trends in science and education to expand the vital competence of young people, focused on the world scientific and educational community (Sugai and Horner 2009). In Kazakhstan, modernization of the secondary education system is increasingly correlated with the processes occurring in the European higher education (Zbar et al. 2010). This is determined by the Bologna process, which resulted in a unified European educational space combined with diversification of higher education, related to the multiple and diverse models of secondary education; new learning environments; institutional changes in the field of education focused on the non-linear

(asynchronous) models; introduced lesson models based on the student-centered learning technology (Arness et al. 1990). However, in Kazakhstan (as well as in many post-Soviet countries), teaching methods are not focused on individualization, which complicates the transition to subject differentiation. In addition, this situation hinders learning.

Two contradictory trends have always been present in science. The first one is focused on the integration of knowledge, its unification in the overall system, disclosure of their relationships, the other one – on knowledge differentiation, its further branching and the emergence of separate, specific branches of knowledge (Nguen and Smart 1996). Scientific progress is determined by the internal unity of these opposing trends – differentiation and integration of scientific knowledge. Differential and system approaches to the school educational process are a multi-dimensional and complex phenomenon that can be regarded from different perspectives. From the psychological perspective, this phenomenon can be regarded as a means of personal identity disclosure and development of its potential, from the pedagogical one – as the basis for a training system designed to efficiently use the potential of the subjects and provide conditions for professional self-realization, and as a specific organization of the educational process; from the social perspective – as a phenomenon that has an impact on personal adaptation in society (Bannert 1992, Bordovskaya and Rean 2000, Enenkel and Smith 2014).

The differentiated system approach to training is the most productive form of interaction among these trends. It presents a didactic system based on differentiation and system principles in terms of creating innovative educational technologies. This system is characterized by integrity, synthesis, generality of its elements, universalization and content specialization; it involves all the elements and components of the educational process and provides functional relationship between the elements of professional training (Stukalenko et al. 2016). On the one hand, the global trend of integration and globalization of the education system can lead to the greatest possible individualization; on the other hand, it requires the development of pedagogical technologies, a holistic worldview, and integrative way of thinking, the ability to perform independent creative search, competence and professionalism. In this context, biological education is one of the integral bases related to student training in the field of natural sciences and

ensuring the integrity of student personality development (Shchukina 1990).

METHODOLOGICAL FRAMEWORK

We have analyzed the regional component of zoology and ecology teaching in socio-cultural and educational contexts. The relation of state and regional components and the local history is a topical issue addressed in this article, as Kazakh schools are based on a component-based model of curriculum development. Thus, a significant part of humanities actually goes beyond the national standard. This fact undoubtedly actualizes the need to understand and to develop the theory and practice of creating regional and local components of general education beyond the state educational standards. Territorial entities of the Republic of Kazakhstan and other countries already have the considerable experience in this area (Bannert 1992, Rupert et al. 2002, Shapkin 2008). We made an attempt to analyze this experience in order to identify and to generalize its positive content that may be useful in developing the regional education systems. The main purpose of studying the regional component and local history is to educate a patriot, who knows his region, town, village (its traditions, natural monuments, history and culture) and who wants to contribute to its development.

RESULTS OF RESEARCH

The need to consider the specific features of the national and administrative territorial development of the country is determined by the social order in the field of ecology education. The use of national and regional acts in student training and education is a distinctive feature of current educational development. Society has recently shown a keen interest in human development in a particular socio-cultural and national environment. Therefore, the growing role of regionalization in youth training and education is one of the most distinctive features of modern education. Personality socialization, humanization of social life and education have determined the choice of qualitatively new conditions for its development, taking into account personal characteristics, motives, interests and value systems. Factors that determine democratization and regionalization of modern Kazakhstani education involve the mainstream of ethno-regional features in the system of youth education and training, as well as their adaptation to modern life.

New trends are currently formed in the field of education at the regional level. On the one hand, these trends reflect regularities of the global educational

process, on the other – national and regional peculiarities caused by historical, demographic, economic, ethnic and cultural factors, as well as by public mindset. The comparative educational research will be greatly improved if all phenomena, processes and trends in the field of education are studied at three levels: international community – Kazakhstan – region. Public strategy in the field of education, in particular, ongoing reforms, variability and regionalization, have a significant impact on all regions. The ongoing rearrangement of the Kazakh educational system can lead to significant progress only if the relevant conceptual framework and peculiarities of regional educational systems are considered. All this taken together leads to a new educational paradigm. This paradigm provides the development of high-quality education, general culture, intellectual development, satisfaction of personal and cognitive interests of students through the study of ethnic culture, national (Kazakh) and world values, history, culture and civilization. This approach defines the invariant nature of the Kazakh modern educational system and points out the possible ways of its development at the regional level.

Specific features of the educational environment provide the possibility of creating an effective educational space in any educational institution. The regional component of the state educational standard creates opportunities for the moral, ethical and aesthetic categories by adhering to the spiritual, cultural and environmental values; it allows considering both natural sciences and humanities as part of the world and national culture. The education quality improvement requires a progressive development of education in the region. Regional educational standards should not only provide a certain level of education, but also stimulate the improvement of its quality. They should be based on certain types of analyzes, carried out with regard to relevant national standards, domestic and international experience in the field on educational standardization, the existing regional level of education, related to the subject (educational) areas of the curriculum, the existing and available teaching logistics, the level of teachers' preparation and the quality of the teacher-training institutions.

Currently, education system development is focused on humanization and ecologization of student training, oriented at practical significance of the acquired knowledge and skills. This can be achieved through the regional component – 10-15% of academic hours. The content of this component should be

supplemented by local area material, which can stir interest in studying biology that provides student adaptation to hard social life. Introduction of local area material into relevant courses on biology provides the possibility of reorienting the teacher from traditional to the real environmental education (Bannert 1992).

In the education system, environmental training should began in primary school, then – in secondary and high school with due account for the age and psychological characteristics of children, and their interests (Bordovskaya and Rean 2000). Local history knowledge about snakes living in Kazakhstan is relevant for the educational space of pedagogical higher educational institutions. The main forms of Local History include the local history studies as an independent subject; knowledge about snakes, included in the biology content for bachelors; research and project activities, organization of student research activities related to species composition; creative work of student clubs during non-school hours, guided tours and hiking. Snakes (Ophidia or Serpentes) are highly specialized legless squamates adapted to crawling in dense vegetation, along the branches of trees and shrubs; they feed on a relatively large prey, which is swallowed entirely. Snakes differ from legless lizards by movable articulation of the left and right halves of their jaws, by no movable eyelids, eardrums, shoulder girdle, free limbs and some other features. Only boas have small vestigial femoral and iliac bones. Vestigial pelvis is also found in blind snakes.

Snake body is covered with small horny scales on top, and with scutes underneath. There are no skin glands there (except for some types of water snakes). Molting takes place in a very peculiar way. The old surface layer of the skin is separated on the jaws and then it is gradually removed from the snake body, twisting like a glove finger. During molting, the surface layer of fused eyelids peels as well and snake eyes become more transparent. The spine consists of many (140-435) uniform vertebrae due to the specific movement. Their structure provides strength and mobility of the spinal column, which is important for crawling by body bending. Vertebrae have freely ending gastralia. Their free ends rest on a layer of muscles connected with abdominal horny scutes. Gastralia movement provides more perfect snake body movement, especially when it comes crawling in a narrow hole. Among the Kazakh snakes, only blindworm's body is covered with uniform scales; all other snakes have a body, which bottom surface is very different from the integument (scales) of the rest of the

body. It is covered with elongated plates (ventral shields). The number of ventral shields is often important in terms of defining snake species and generally corresponds to the number of vertebrae. Ventral shields end with the anal shield located before the cloacal aperture; this shield can often be divided into two parts by an oblique seam. The bottom surface of the tail is covered with shields, which are arranged in two longitudinal rows (the so-called subcaudal shields) in many Kazakh species; in some species, part of these shields can be divided, in other species, they remain undivided.

The number of scales around the snake's body often is important to identify species; in many cases, correct counting determines the correctness of their identification. One can count the number of scales around the snake body and the number of ventral shields by using a pin or a needle, touching each scale, shield or scute with its tip. Needles or pins can be also helpful in distinguishing the place where counting was interrupted for some reason (for example, in the case one needs to rotate the studied object). In counting the shields, one should pay attention to the tail integrity, in order to prevent possible errors in determining snake species (Burukovsky 2000).

Sarcosporidia – intracellular cyst-forming Coccidia. They are characterized by obligate heteroxenous development cycle that takes place in two hosts according to the predator-prey principle. The sexual process and sporogony are usually carried out in a predator's body, which is the definitive host (Morozova et al. 2013). After penetration of mature sarcocysts into the definitive host's intestine, their shell is digested and merozoites penetrate into the villi stroma of the small intestine, where gametogenesis occurs by passing the intestinal asexual stage with the formation of macro and microgametes. Their interflowing forms the zygote (oocyst). Oocysts are sporulated in the host's intestine and then they are released into the environment together with the faeces. All oocysts have isospore structure (two sporocysts, each of them contains four sporozoites), coated with a thin, barely visible shell; they easily fall into individual sporocysts. These sporocysts can directly infect the intermediate host by penetrating into its intestine. Asexual reproduction occurs mainly in the body of non-predatory animal (intermediate host); it is divided into two stages – pre-cystic and cystic.

In the pre-cystic period, the parasite causes generalized infection of the animal's internal organs, where it proliferates through schizogony (Coleman

2015). A few weeks later one can witness cystic stages in the animal muscles, filled with rounded immature metrocytes (Darinskii 1996); their further development ends in the formation of cells with different sexual potency: merozoites and gamonts giving rise to sex cells – gametes. Muscle cysts usually reach maturity two months after the infection. Thus, intracellular parasitism and the complex life cycles of sarcosporidia is an important feature. Despite the large amount of accumulated information, the overall picture is still incomplete. Sarcosporidia in wildlife are very little studied. Successful control and prevention of sarcocystis infection requires profound knowledge of parasite's morphology, development cycle and the parasite-host relationship. Therefore, further studies of sarcosporidia are important in terms of both theory and practice (Childibaev and Ermekbaeva 2015).

This study deals with studying the fauna development cycles and micromorphology of Sarcocystis in some rodents and birds. These issues were studied through experimental models with laboratory and wild small vertebrates as the most available objects of research. Comparative studies, related to the morphology of sarcocysts and sporocysts of different species of mammals and birds, were carried out with a light microscope identifying various shapes and sizes of cysts, merozoites and the structure of cyst walls. The size and form of cysts depend on their age and maturity. The most stable diagnostic feature of mature sarcocysts in different animal species is detected by using light microscope. It is a cyst wall structure and the size of mature asexual stages of their development – merozoites. In some cases, morphological features of the cystic wall and mature merozoites can be distinguished only with an electron microscope (Coleman 2015).

In determining the type of sarcosporidia, one should consider the form of intermediate and definitive hosts along with morphological and biological properties of the parasite. Like other Sporozoa, Sarcosporidia belong to parasites strictly specific to the intermediate host. With some exceptions, research literature provides information on the transfer of sarcocysts from the forest mouse to the house one Bordovskaya (2000) from the bank vole to laboratory rats (Darinskii 1996, Goddard and Goddard 2007). Thus, biological structure of snakes and sarcosporidia reveals the need to move to a differentiated approach to learning by performing independent work. In the course of the independent work, students will demonstrate their individual abilities (Enekel and Smith 2014). It will also give the

possibility of providing the in-depth and comprehensive training.

Biology teaching methods consider mainly the age characteristics of students, and to a lesser extent – their personal traits. For objective reasons, modern teachers do not have enough time to organize special independent work of students focused on their mental activity. Thus, teachers are forced to provide “quick learning”, often neglecting the individual readiness of each student to understand a particular theoretical material. Keeping in mind the present state of zoology and ecology teaching, this type of work is very difficult, since almost the same amount of teaching material should be studied within the same period. Nevertheless, life forces teachers to move to a differentiated system approach to zoology and ecology teaching – to study the personality traits of each student in order to provide an individual approach to zoology and ecology teaching. Differentiated individual work of each student is an important element in addressing the key problem of higher school – high-quality education. It promotes the consolidation of educational material along with active and purposeful acquisition of new professional knowledge and skills. It also develops the ability to work with scientific literature and relevant information sources, motivates to self-education and determines what skills, abilities, knowledge and cognitive techniques shall be developed. In addition, this work generates interest in creative work, in using a differentiated approach to learning.

In implementing the differentiated approach to teaching, one should not overlook the system approach to the presentation of ideas related to biological systems and living organisms. The need to provide a system approach to nature studies was substantiated by Vsesvyatskiy (1938), who justified the need to study the biological systems in all life forms, including morpho-physiological, historical, physiological, ecological, genetic and evolutionary, biological and applied aspects (Goddard and Goddard 2007). In considering the animal kingdom from unicellular to chord organisms (“Zoology and Ecology of invertebrates and vertebrates”), one should focus on the existence of interconnections among the elements of any biological system, as well as on the external connections with abiotic, biotic and anthropogenic factors (Star, Griesemer 1989). Anthropogenic factors often change the quantity and quality of energy, matter and information supplied to a particular biological system, which inevitably leads to changes in its functioning and to disruption of its dynamic equilibrium. Therefore,

one has to disclose the mechanisms that give the possibility of keeping the integrity of each population and its dynamic equilibrium, determined by self-regulation processes. Besides, in zoology and ecology course, the study of individual representatives of the animal kingdom and related environmental issues should be considered in two ways: statically, excluding its real existence dynamics, and in dynamics. Namely, one should study their development: origin, formation and evolution.

Training content and plans for its adoption should be based on individual characteristics of each student (apparent mental operations, attention, memory, verbal skills, etc.). Let us consider two diametrically opposed groups of students: the weak and the strong ones. Weak students require especially thoughtful approach. In working with them, teachers should give the material in such a way that could help them to achieve some success in their own training activities. At that, one should take into account their psychological and individual features. Such students should not be called to the blackboard without any preliminary preparation; one should cautiously involve them in conversation during classes, in a dialogue during relevant seminars. Teachers should also give these students the possibility to be included in the so-called general-training work. It is important to call them to the blackboard (or to let them speak staying seated at their desks) if they wish it. As a rule, these students avoid complex, independent work that requires patience, perseverance and considerable willpower. Nevertheless, these students listen to the teacher’s explanation with great interest, in case the material can be understood without any effort on their part.

Besides the relatively passive attention, students gradually start considering certain issues and they feel that they understand relevant material. This feeling gives them a desire to participate more actively in class; it generates self-confidence and interest in the studied subject. Gradually, teachers have to ask them to independently prepare a short message for a group of students, or to organize a small demonstration / experiment in the classroom. Their participation along with their “special” position in relation to the rest of the students will contribute to the development of their sense of responsibility, the desire to perform without mistakes.

In addition to the accumulated knowledge and skills related to independent work, many weak students began to show their interest in zoological studies. Let us note

some methodological techniques that could be helpful in organizing independent work with such students (Ruppert et al. 2002).

Independent work provides knowledge of:

- Particular structural-functional organization of animal organism;
- Animal mechanisms of adaptation to the habitat in the process of their evolution;
- The role of invertebrates in nature and in human life.

Students should be able to:

- Systematize knowledge of the invertebrates, obtained during the study of scientific literature;
- Competently expound the theoretical material related to animal life, its important role in human life, in the life of other organisms and the entire biosphere;
- Use knowledge, gained after studying the course “Zoology and Ecology of invertebrates and vertebrates”.

In everyday life and professional activity, students should be able to use computer skills and Internet resources. Independent work should strengthen and develop the following competencies:

Instrumental competencies (IC)

IC-1: ability to perform written and oral communication in a mother tongue;

IC-2: ability to use basic technical skills in professional activity: to use a computer and computer networks, to use the universal software packages, to create web-based resource databases;

IC-3: information management skills;

IC-4: ability to use basic knowledge and information management skills to address professional research tasks.

Socio-personal competencies (SPC)

SPC-1: showing creative qualities;

SPC-2: taking care of work quality.

General professional competencies (GPC)

GPC-1: demonstrating the basic understanding of how diverse the biological objects are and how important the biodiversity is for the biosphere stability; **GPC-2:** understanding the role of evolutionary ideas in the biological worldview; having modern vision of the evolutionary theory, as well as of the micro- and macro-evolution (Shapkin, 2008). Independent work provides the possibility of forming social and personal competencies, as well as research skills. In the course of the independent work, students consider additional sections of the course (30 academic hours) by using the recommended literature, writing essays (15 academic hours), performing tasks (18 academic hours), self-testing on relevant topics of the discipline (20 academic hours). In performing different tasks, students take a closer look at the processes of analysis, comparison, sources use, argumentation and justification of findings and conclusions.

CONCLUSIONS

Differentiated ecology and zoology are focused on creating optimal conditions to identify the main skills and to develop interests and abilities. They are characterized by the formation of student groups. The main traits and skills include those that are in the training standard, as well as the learning abilities and cognitive interest. We have found that modern educational system provides great opportunity for differentiation. The number and variety of ways for a differentiated approach to be implemented depend on the teacher's pedagogical skills, his/her ability to work directly with the entire class and each student individually as well as on modern challenges and trends in ecological/biological education. The study shows that teachers-biologists and ecologists, who used differentiation in teaching schoolchildren, have noted its efficiency and expediency. We should also note that an individual approach to each student is required as an indispensable prerequisite of differentiation in teaching and learning.

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