

Alternatives in biological education as a way to implement an ethical approach to the formation of subject and professional competence of future teachers

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Abstract. *Research objectives:* the article analyzes the experience of using alternative means of teaching biological disciplines, the purpose of which is to partially or completely replace biological objects in educational practice with their visualized copies. *Object of study:* ethical approach as a leading approach to the teaching of biological disciplines. It is based on the idea of minimizing harm and risk to animals as objects of study when organizing training in biological disciplines. *Subject of study:* the experience of using ready-made alternative teaching aids obtained in the framework of international cooperation and creating their own in teaching biological disciplines to students. *Research results:* tested alternatives obtained in the framework of international cooperation, identified difficulties and limitations of their use in teaching university students, created alternative means of teaching plant physiology – a video sequence of domestic experiments on plant physiology. The quantitative results of the intermediate and final certification of students allow us to state the preservation of the average score in the disciplines “Anatomy and Physiology” and “Methods of Teaching Biology” in comparison with previous years. The quantitative results obtained make it possible to judge the effect of the applied alternatives on the degree of formation of subject competence of students. Assessing students' understanding of the ethics of alternative means used, their importance in the formation of elements of teacher's professional competence lies in the area of further development of the topic.

Keywords: ethical approach, alternatives, subject knowledge, professional competence, ethical thinking, alternative teaching aids.

1 Introduction

1.1 The problem statement

According to the 2030 Agenda for Sustainable Development adopted at the 70th session of the UN General Assembly, 17 new global goals will be included in the subject field

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of education for sustainable development [17]. It should be noted that according to the Incheon Declaration [9], education is the main driving force in transforming people's lives and achieving sustainable development goals. You need to understand that we are talking about a global revision of value orientations, primarily in the field of education, and, accordingly, changes in the behavioral attitudes of the individual and society as a whole. It is predicted that one of the vectors of such a transformation will be orientation to ethical education at all its levels, to education, where the interests of life as the highest value are paramount.

1.2 The state of the art

The question of the relationship of ethics and science in biological research in different eras was solved differently [16]. So, in the era of antiquity the principle of “watch no touch” prevailed. The principle was dictated by the realities of that time, when the volume of knowledge of mankind about living nature was simultaneously negligible and sufficient for a long-term and even centuries-old contemplative state.

In the Middle Ages, the church imposed a ban on manipulating the human body in the post-vital period. However, the socio-historical processes associated with the opening of new geographical horizons, the rapid development of technology, the transition from manufactory to factory production, led to an increase in the urban population and, accordingly, to increased risks of the spread of diseases of an infectious nature. The current contradiction between the church ban and the objectively low level of development of medicine, based on a small amount of scientific knowledge on anatomy, human physiology, led, on the one hand, to the emergence of the profession of “grave robbers”. On the other hand, the objective necessity of “legalizing” the anatomy of the human body, studying the mechanism of physiological processes in it, and the occurrence of responses to ongoing manipulations was revealed.

In the era of modernity and the maximum availability of the necessary tools for conducting complex intraorganic and intracellular manipulations, in conditions where, it would seem, on the contrary, take and examine, we are witnessing a change in the ethical principle of scientific research to “refine, replace, reduce”.

The successive change of the prevailing ethical principles in the field of natural science, in particular, biological research, is determined, in our opinion, by two reasons.

The first reason is that a person is gradually approaching such a level of knowledge about nature and himself, when awareness and acceptance of himself as part of living nature, a part that obeys and lives by the same basic laws of life as all its other elements.

Another reason lies in the leading factor, which determines the choice of a strategy for the attitude of a scientist to the studied object of wildlife. Such a factor is the set of cognitive tools available to the scientist. The availability of the latter is determined by scientific and technological progress and the level of development of productive forces. The origins of the question of ethics in natural science research lie precisely at the time when the question of ethics itself was not raised. The reason for this is a poorly developed, practically absent instrumental base for research.

Objectives of the use of animals in educational practice.

The use of animals in the practice of teaching students of biological specialties has as its goal:

1. The study of the internal structure of the animal to familiarize themselves with the topography of organs, their shape, size, color.
2. The formation of subject competencies of students of biological specialties in recognizing internal organs, describing their structure, and performing schematic sketches.
3. Demonstration to students in the process of setting up a physiological experiment through vivisection of the animal of physiological processes, the laws underlying physiological laws.
4. Development of practical skills in catching, determining invertebrates and chordates, compiling collections, and making carcasses.
5. Conducting student training / practice.

As noted by Dimitrii Leporskii, one of the ambassadors of the international organization InterNICHE [4] in Ukraine, as well as colleagues from the Center for the Protection of Animal Rights "Vita", when studying a number of biological disciplines, the university has the practice of using animals as experimental objects. So, on the anatomy, animals are sacrificed for the purpose of subsequent dissection. In the study of biochemistry, physiology, pharmacology, experiments are conducted with drugs obtained from live animals (frog nerve, guinea pig ileum). In the study of physiology and pharmacology - experiments on living animals to study the effect of drugs and hormones on the body. In clinical practice, the skills of capturing and retaining an animal, injecting, and examining internal organs are practiced. In surgery, students of medical and veterinary universities and animal faculties perform an operation on internal organs, perform castration, treat wounds and wounds.

The use of animals in the educational process of a modern school implies a less traumatic practice for representatives of the animal kingdom, without vivisection and postvital incisions.

When teaching biology at school, animals are used to:

1. Familiarization with the peculiarities of the external structure of animals (on macro preparations and living objects).
2. Statement of a biological (physiological, genetic-selection) experiment without vivisection of the animal.
3. Organization of observations of individual and species behavior of animals.

Separately, it is worth mentioning the study of the internal structure of the animal on fixed histological micropreparations. Note that the factory-made drugs themselves are not manufactured in the classroom.

Definition of humane education and alternatives in education and scientific practice.

In the modern world, a movement for humane education is gaining momentum not only in medical [1; 4; 5; 15], but also in pedagogical universities [10; 14]. A humane education is an education that develops compassion, empathy, respect for life in all its manifestations. Humane education refers to education where goals are achieved through humane, alternative teaching methods and the use of alternative teaching aids. Humane education is also considered as one where animals are not subjected to violence and cruelty, and students have freedom of conscience (choice). This is a refusal to study the content of the subject and mastering professional skills by harming the animal. Alternatives are a substitute for natural visibility and working with it. Note that the experience of replacing real animal objects with alternatives in the educational process in biology in high school dates back to the late 90s [2; 3; 6; 11; 12]. Today, the issue of the full transition to alternative training in biological disciplines at school, related methodological features and difficulties, is actively being discussed. Just look at the list of recommended sources on the site <http://www.interniche.org/>.

Alternatives are learning tools or approaches that replace experimentation with animals that harm them. It should be separately emphasized that the key to understanding the purpose of using alternatives is the elimination of harm to the object of study. What is meant by the term “harm”?

Harm means any intentional or unintentional action that affects the current or future welfare of the animal, denying or restricting any of the following rights:

- the right to live;
- the right to fully exhibit natural behavior;
- the right to be part of a social structure and ecosystem;
- the right not to experience hunger and thirst;
- the right not to feel discomfort;
- the right not to experience pain, damage or illness;
- The right not to experience fear and distress.

At the moment, the main types of alternatives are:

- videos;
- models, mannequins and simulators;
- computer simulation and virtual reality;
- corpses, organs and tissues obtained from ethical sources;
- experimenting a person on himself;
- in vitro studies.

Despite the rather short history of the development of the movement for humane education (late 90s of the XX century), a number of erroneous ideas arose about the effectiveness of using alternatives in educational practice. We characterize them:

Myth 1. Replacing experiments means the absence of the main learning tools - animals.

In fact: “substitution” means “no harm” and may include neutral treatment of animals or work that benefits the animals.

Myth 2. Live animals are an integral part of education and educational practice.

In fact: effective education and training do not always require the involvement of animals.

Myth 3. Experimenting on animals is “real practice”.

In fact: it is important to distinguish between a method and a goal. Experimenting with animals is a method. The goal is to acquire knowledge and skills. All students who will deal with animals in their careers will receive this opportunity after training. It is also important to say about the problem of desensitization, which occurs in hidden messages about the permissibility of using animals in the educational process. Most often, such messages are negative. Learning the “permissibility” of instrumental use of animals contributes to neglect of life and the development of desensitization. We believe that due to the specifics of the professions obtained, the problem of desensitization is extremely relevant not only for students of medical, veterinary, but also pedagogical universities. Lowering the sensitivity and lowering the rate of emotional response is fraught with the education of future doctors, veterinarians, teachers with unacceptably low levels of empathy, empathy and compassion, which we consider not only as personal, but also professional qualities.

The successful introduction of alternatives affects many aspects of not only educational practice, but also social life. So, replacing animal experiments with humane alternatives affects:

- the quality of education in general;
- philosophy of natural science. It is worth recalling the historical way of changing the basic ethical principles of natural scientists;
- emotional and ethical literacy of representatives of professions man - man, man - nature;
- civil rights and freedoms in the choice of educational content.

Replacement of experiments on animals, refusal to cause harm in any form:

- has a practical positive impact on the environment and extends the rights of animals;
- has economic benefits. It is economically viable to invest in the development of high-quality alternative training equipment and facilities, rather than incur costs from maintaining, caring for animals, treating sick animals, and disposing of biomaterial.
- forms a positive reputation of educational and research organizations such as those that adhere to ethical practices in the teaching of biological disciplines and scientific research;
- changes the law [7].

1.3 The purpose of the article

The article analyzes the experience of using alternative means of teaching biology and biological disciplines, which have as their goal the partial or complete replacement of biological objects in educational practice.

2 Results and discussion

2.1 The technological aspect of use

In 2017, a tripartite agreement was signed on cooperation between the Department of Zoology and Biology Teaching Methodology of Kryvyi Rih State Pedagogical University and the Doctors Against Animal Experiments (<http://www.aerzte-gegen-tierversuche.de/>) and InterNICHE (www.interniche.org) [8].

The leading resources of partner organizations of the pedagogical university were their websites www.interniche.org, www.gumannoe-obrazovanie.org

In general, partner organizations provide support to educational organizations conducting training in undergraduate and graduate programs in biological, medical, and veterinary specialties. Partner organizations provide information support to those who express a conscious protest to harming the animal for educational purposes. In the framework of cooperation, conferences, field events – workshops, educational trainings, individual counseling of teachers implementing work programs are organized. Remote cooperation is organized through the website www.interniche.org (fig. 1). The site is multilingual, interactive, content and functionality are regularly updated.

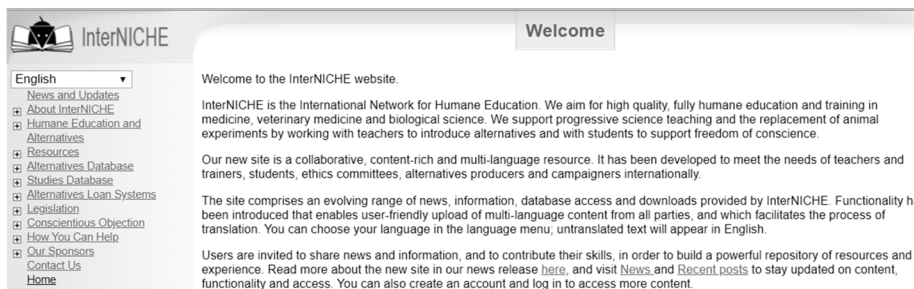


Fig. 1. Site's home page <http://www.interniche.org/>

Within the framework of the concluded agreement, the provided alternatives were tested.

The use of alternatives took place during classes in the disciplines:

- Methods of Teaching Biology;
- Methods of Teaching Biology in a Specialized School;
- Experimental work in biology.

Taking into account the specifics of the taught disciplines and the implemented forms of classes, the alternatives provided for use were distributed as follows.

In laboratory classes on the “Methods of Teaching Biology” and practical classes on the “Methods of Teaching Biology in a Specialized School”, experimental work on biology, the following were used:

- DVD Anatomy of the Grasshopper;
- DVD Anatomy of the Earthworm;
- DVD Anatomy of the Starfish;
- DVD Anatomy of the Perch;
- DVD Anatomy of the Shark;
- DVD Anatomy of the Freshwater Mussel;
- DVD Anatomy of the Crayfish;
- CD BioLab Invertebrates;
- CD BioLab Frog;
- CD Biolab Fish;
- CD Blood and Circulatory System;
- CD The Human Nervous System;
- Set of 5 DVDs Soviet Life science education films;

In practical classes (seminars) on the “Methods of Teaching Biology” were used:

- book and DVD by A. Naglov, National University of Kharkov;
- book and DVD: “Using alternative methods in studying of cardiovascular and respiratory system physiology”;
- book “Bioethics in Higher Education” by T. Pavlova.

Adjustments were made to the work program for the discipline “Methods of Teaching Biology”, namely, a practical lesson on the topic “Bioethical Aspects of Teaching Biology at School”, a laboratory lesson “Using Information and Computer Technologies and Alternatives in Teaching Biology in 7th Grade” is provided.

Alternatives as demonstration material were used by students of the Faculty of Natural Sciences during their pedagogical practice at school in grades 7-8 when studying zoology and human biology.

A round-table discussion was held with 4th year students of the specialties “Biology and Chemistry”, “Biology and Practical Psychology” on the topic “Bioethical attitude to animals in the legislation of Ukraine and other countries”.

One of the indicators of the effectiveness of using ethical alternative means of visualization, in our opinion, should have been universal indicators of the effectiveness of the educational process – the quality of knowledge and academic performance in the disciplines. To clarify, the active practice of using alternative teaching aids in the

discipline “Methods of Teaching Biology” was started in the 2nd semester of the 2017/2018 school year and continued throughout the entire 2018/2019 school year. Upon completion of the study by students of the discipline “Methods of Teaching Biology” (January 2019), an oral exam was conducted, quantitative results were obtained. The results of training students in the discipline “Methods of Teaching Biology” with the used alternative means were compared with the exam results of training in the same discipline without using alternatives in previous years (2017, 2018). A comparison of the results is shown in fig. 2.

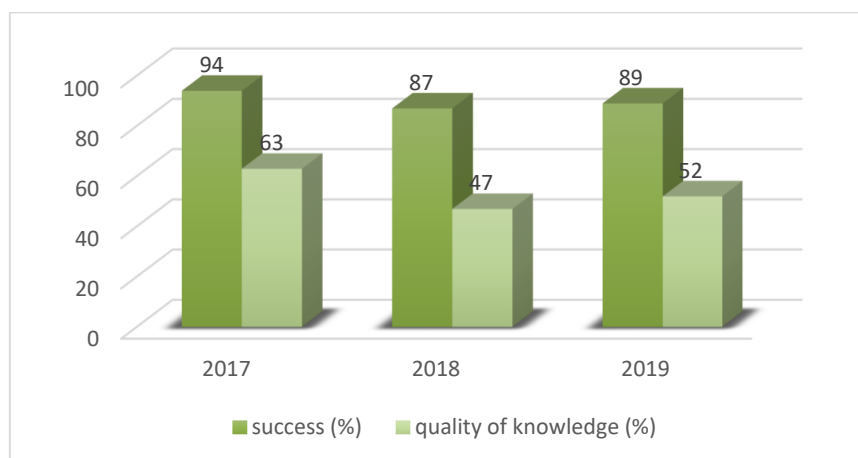


Fig. 2. Quality and performance in the discipline “Methods of teaching biology”.

The quantitative results of mastering the discipline in the first year of using alternative means did not show a drop in such indicators as the quality of knowledge and academic performance. We consider such a result as positive. At the same time, we believe that it is necessary to track these indicators in the future in order to formulate an unambiguous substantiated conclusion.

The practice of using alternatives in the educational process of a pedagogical university when teaching biology students allows us to state the following.

Firstly, alternative teaching aids are uniquely capable of completely replacing the use of live animals in developing the professional skills of future students of biology teachers in their study of the disciplines of methodological content.

Secondly, alternative teaching aids, even if the natural objects are partially replaced, contribute to the formation of a student’s personal conviction as a future biology teacher in the absence of the need to use live animals or their remains to demonstrate the morpho-anatomical structure or physiological characteristics of organisms. The latter can be successfully done using alternatives, while preserving the life of many representatives of the animal kingdom and promoting the idea of ways to preserve biodiversity on the planet.

Thirdly, the use of alternatives as a means of teaching students of a pedagogical university to a large extent prevents the coarsening of the soul and the development of

callousness as personal qualities of a future teacher, since the principle of ethics is put at the forefront of working with biomaterial. We understand the principle of ethics as a relation to life in all its manifestations as a basic value.

The difficulties in using alternatives in teaching biology students were caused by the following factors.

- the prevalence of English-language content in the materials presented. This complicated both the process of installing educational content on the computer's hard drive and caused difficulties in understanding the essence of the task for all users of alternatives;
- the effectiveness of the use of alternatives is significantly increased if students work on personal computers. This is how it is possible to carry out laboratory work to study the physiology or anatomy of an animal. In practice, due to the insufficient material security of the laboratory, methods of teaching biology with computers, classes were conducted demo, students acted as passive listeners and observers of actions performed by the teacher.
- the use of alternatives as a replacement for live and euthanized animals will achieve maximum efficiency provided that the educational process of the pedagogical university, faculty or department is maximally involved in the idea of humane education. This requires refusal or the maximum transition to a training format without the use of animals, their preparations in any form.

We consider fundamental the idea that the formation of professional competencies of future biology teachers is quite possible to realize only using alternative teaching aids.

We do not undertake to assert that such an idea is feasible in specialized medical and veterinary higher educational institutions, however, in the system of higher pedagogical education this is one of the promising vectors of future development.

2.2 The ways of implementation

In the 2019/2020 academic years, alternative teaching aids were tested in practical exercises in anatomy and physiology at the Immanuel Kant Baltic Federal University. The course of anatomy and physiology using only alternatives without the use of animals or their parts in any form was developed for 1st year students of specialties "Preschool education. Speech therapy activities", "Mathematics. Informatics", "Primary Education", "Technology. Additional education (technical and artistic-aesthetic creativity)".

As part of the study courses, the following alternatives were used:

- CD Physiology Simulators (Russian);
- CD Blood and Circulatory System;
- DVD Experiments on the isolated rabbit heart in the Langendorff apparatus (Russian);
- DVD Experiments on the physiology of heart and circulation of the rabbit (Russian);
- DVD Anatomy and function of the skeletal muscle (Russian);

- DVD Experiments on the impulse generation and conduction in the frog heart (Russian);
- DVD Circulation Experiments on the rat (Russian);
- DVD Renal microcirculation (Russian).

The materials presented were used at lectures and practical classes in the discipline.

At lectures, content was provided to students in a demonstration way through a multimedia projector. The practical exercises coincided with the active use of distance learning technologies in higher education related to the introduction of a number of measures aimed at preventing the spread of coronavirus infection. Note that the reorientation to conducting practical exercises in a remote format made it possible to maximize the possibilities of the presented alternatives. Firstly, part of the materials presented was posted on a personal YouTube channel with the ability to watch videos by students using the link located in the LMS-3 system.

On the eve of the practical lesson, students had the opportunity to review the proposed material and prepare for the discussion organized at the lesson itself, which was conducted through the Zoom and Webex platform. During the lesson, the teacher showed his screen, including videos of the corresponding alternative, and in the mode of disabled author's sound, commented on the video, using the method of stopping the video or re-viewing it.

The use of alternatives in this case supported the educational process at a level corresponding to the content of full-time study of anatomy and physiology, which required the use of natural objects, living and fixed.

We emphasize once again the idea that in a higher pedagogical educational institution the use of alternatives as the only means of teaching disciplines, the contents of which previously required the use of natural visibility in the form of live or prepared animals, their remains, parts, is entirely justified and realizable.

Experimental training of students in the discipline "Anatomy and Physiology" using only alternative teaching aids on the basis of the Immanuel Kant Federal Baltic University was carried out in the academic year 2019/2020. At the time of writing, the educational process was in an active phase. This explains the lack of relevant quantitative results confirming or disproving the effectiveness of the funds used. However, the received oral feedback from students about the quality of the material presented and the comprehensibility of the studied objects and processes can be regarded as a positive result of the experiment.

An analysis of sources on the research topic showed that the concept of alternative education is used in understanding alternative education using animal models and their parts with virtual models, experiments, real models, interactive atlases, etc. We believe this approach is currently somewhat limited. We are considering the possibility of alternative training in biological disciplines at the university and biology at the school also using alternatives to minimize the use of plant objects for educational purposes. And here we also emphasize the idea of achieving the priority of the educational goal, and not the scientific one.

As part of the study of the possibilities of using alternatives to plant objects, a study was conducted at the Kryvyi Rih Pedagogical University on the topic "Methods of

Using the Botanical Household Experiment as a Means of Forming Subject Biological Competence of Students”.

The paper demonstrates the possibilities for expanding the boundaries of the use of alternatives in biological education for both students and schoolchildren when they study plant physiology.

The result of the work was the creation of a video sequence kit on the progress of physiological experiments with plants. In order to popularize the created materials and promote the practice of moving away from the use of plant objects for educational purposes, the YouTube channel (https://www.youtube.com/channel/UCw_aj7KvCFC33uGXc7Bk1A/video) was created on which the created materials are posted (fig. 3, fig. 4, fig. 5).

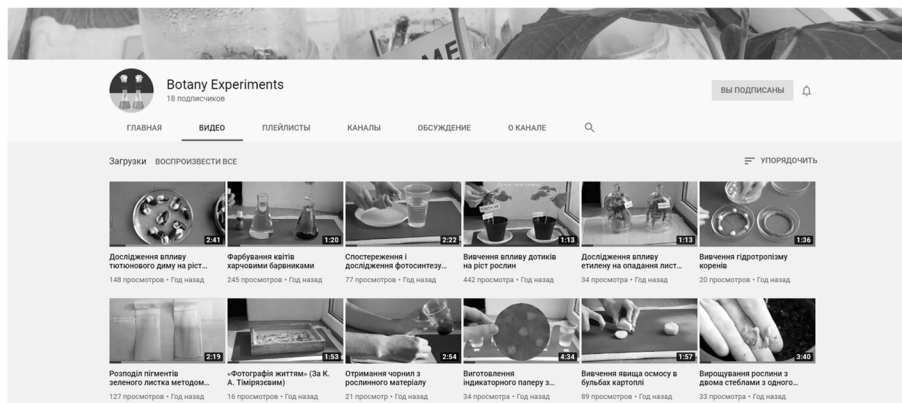


Fig. 3. YouTube channel home page.



Fig. 4. The results of an experiment to study the effect of ethylene on leaf fall (artificial leaf fall).



Fig. 5. The results of an experiment to study the effect of tobacco smoke on plant growth.

Note that this practice of alternative experimentation has several goals:

1. For students – future biology teachers:

- teaches skills in creating elements of an electronic educational environment in biology;
- contributes to the formation of professional competencies in mastering modern teaching technologies;
- forms a conviction of the possibility and necessity of a humane approach to the study of not only animal organisms, but also plant ones;
- positively affects the formation of confidence in the unity of approaches to the study of all manifestations of living things.

2. For students at school:

- contributes to the formation of the belief that animal and plant organisms are different manifestations of one phenomenon – Life;
- forms a conviction that the conservation of biodiversity is possible through humane treatment not only with animals, but also with plants.

To kill a living organism, in this case a plant, to study intraorganism processes for educational purposes, is an optional practical experience. It can very well be replaced with a one-time share of using a small number of objects to create an alternative means of instruction. The latter can be reused, i.e. reproduced.

In the performed work, for an example of creating alternatives, themes were taken for physiological experiments that do not require modern expensive laboratory equipment.

1. The study of the effect of cigarette smoke on plant growth.

2. Dyeing flowers with food colors.
3. Observation and study of photosynthesis using floating leaf discs.
4. The study of the effect of touch on plant growth.
5. The study of the effect of ethylene on leaf fall (artificial leaf fall).
6. The study of hydrotropism of roots.
7. The distribution of green sheet pigments by paper chromatography.
8. “Photography by life” (according to K. A. Timiryazev).
9. Ink production from plant material.
10. Production of indicator paper from solutions of anthocyanins.
11. The study of the phenomenon of osmosis in plant objects.
12. Growing plants with two stems from the same seed.

The paper analyzes the shortcomings and possible difficulties of using the created alternatives, among which: demonstration of mainly qualitative characteristics of a botanical experiment, limited use of quantitative methods, instrumental errors. At the same time, the botanical applied household experiment, including in the form of an alternative learning tool, has several advantages compared to the traditional experiment, namely: accessibility, creating problem situations close to the realities of life, interesting topics, and strengthening students’ motivation to study biology. The content component of an alternative physiological experiment allows you to implement the program of the subject in the application of distance learning technologies with virtually no loss in the quality of the result – formed students’ ideas about the basic processes of plant life.

3 Conclusions and outlook

We see the prospects for further research, firstly, in the development of the training module “Bioethics in Biological Education” for students of biological specialties at pedagogical universities. The module is designed for students mastering the discipline “Methods of Teaching Biology” or “Pedagogical module”. We consider it necessary, within the framework of the module, to familiarize students with the possibilities of using alternatives in the practice of teaching biology at school, when studying both plant and animal objects in school. Secondly, we consider it important to concentrate efforts on expanding the practice of using ready-made alternatives when teaching students of biological specialties of pedagogical universities, taking into account the specifics of the resulting specialty. Thirdly, the study will focus on the methodology of teaching students – future biology teachers – to create author’s alternative teaching tools aimed at minimizing the use of animals in the educational process.

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