The Values of Biological Education from the Point of View of 2020 Events (or Biotechnological Human Improvement through the Eyes of Students)

Elena V. Komarova[1][a] and Arnold E. Kiv[2][b]
[1]*Immanuel Kant Baltic Federal University, 14 Aleksandra Nevskogo Str., Kaliningrad, 236041, Russia*
[2]*Ben-Gurion University of the Negev, P.O.B. 653, Beer Sheva, 8410501, Israel*

Keywords: Terminal Values, Instrumental Values, Biological Education, Human Enhancement, Bioethics, Future Teachers of Biology.

Abstract: The main idea of the research is that the value potential of academic disciplines contributes to the implementation of the idea of sustainable development in the framework of secondary and higher biological education. As a result of a study carried out in 2019, we found that in basic school the content of the subject "Biology" is primarily aimed at the formation of ideas about the main terminal values – "life", "health", "nature"; in high school – about terminal values – "life", "health", and also about instrumental values – "persistence". In our 2020 study, we investigated the influence of the bioethical content of biological disciplines on the formation of value ideas of future biology students and future biology teachers about modern scientific innovations (using the example of genome editing and biotechnological human improvement), the development of the ability to evaluate them from a bioethical point of view. It is assumed that the formation of the ability to give a bioethical assessment of events taking place in the scientific world and ongoing discoveries is one of the main in the implementation of the idea of sustainable development in the field of education.

1 INTRODUCTION

At the beginning of 2020, the world did not even suspect about the consequences of those global challenges and catastrophic changes that would fall on it in an avalanche in a matter of weeks. On December 31, 2019, WHO was informed of the detection of cases of pneumonia of unknown origin in Wuhan, China. Two months later, on March 11, 2020, WHO Director-General Dr. Tedros Adhanom Ghebreyesus will declare that the outbreak of COVID-19 can be described as a pandemic (WHO, 2020). The subsequent chain of events in 2020 became proof that biology in today's world is one of those sciences that develops strategically important mechanisms for the survival of all mankind as a whole and each individual individually. The reverence for biological science, with its realities and possibilities, which has rapidly increased in less than a year, actualizes the need to revise the goals and values of biological education. In the light of the current events, the understanding of the role of biology in ensuring the sustainable future of mankind becomes all the more urgent.

At the 70th session of the UN General Assembly, the 2030 Agenda for Sustainable Development was adopted. It includes 17 new global goals that will be included in the subject field of education for sustainable development (Grachev et al., 2017).

According to the Incheon Declaration (UNESCO, 2015), education is considered as the main driving force for transforming people's lives and achieving sustainable development goals. We are talking about the development of skills, value orientations and behaviours that enable citizens to lead a full, healthy life, make informed decisions and respond to local and global challenges through education for sustainable development and education in the spirit of global citizenship (Grachev et al., 2017).

Education for sustainable development is an international vector of education and enlightenment of a person throughout his life, which is implemented in the interests of human capital development, in order to preserve the cultural and natural heritage of the planet for generations (Dzyatkovskaya and Zakhlebnyi, 2016).

There are several models for the implementation of education for sustainable development: natural sci-

[a] https://orcid.org/0000-0002-3476-3351
[b] https://orcid.org/0000-0002-0991-2343

Komarova, E. and Kiv, A.
The Values of Biological Education from the Point of View of 2020 Events (or Biotechnological Human Improvement through the Eyes of Students).
DOI: 10.5220/0010924500003364
In *Proceedings of the 1st Symposium on Advances in Educational Technology (AET 2020) - Volume 1*, pages 365-380
ISBN: 978-989-758-558-6

ence, interdisciplinary and school-wide (Koryakina, 2012). In the framework of the natural science approach, education for sustainable development is considered the successor to environmental education (Koryakina, 2012).

On a global scale, changes in educational systems aimed at adopting the idea of education for sustainable development have been taking place since the early 2000s (Grachev et al., 2017; Koryakina, 2012).

Today, education for sustainable development has two methodological problems (Abdurahmanov et al., 2010).

The first is connected with scientific foundations, since a classical scientific school cannot fully meet the principle of scientificness in modern conditions (Abdurahmanov et al., 2010).

The second methodological problem is the futuristic prognostic nature of education. The growing capabilities of information technology in an irrepressible progression require students to learn how to predict the future steps ahead.

Therefore, it is relevant not only to teach to analyze and draw conclusions, but to predict, envisage the future, and model the activity in the long run. Another difficulty in the formation of education for sustainable development is called the blurring of its content: knowledge, methods of activity and value-semantic attitudes (Dzyatkovskaya and Zakhlebnyi, 2016).

The concept of "sustainable development" is twofold.

On the one hand, sustainability provides stability, fundamentality, in a certain sense stagnation. On the other hand, development is based on transformation, change, improvement.

Out of this we conclude that a system that is in a state of sustainable development includes unchanged or hardly changed fundamentals and permanent deviations, summarizing as a result in a new quality. What constitutes an unshakable foundation, and what is subject to changes in the framework of science education for sustainable development in general and biological in particular, these questions have to be answered.

The effectiveness of any educational system is evaluated according to the final result. According to the culturological theory of the education content, the results of education are knowledge, reproductive experience, experience in creative activity, and experience of an emotional-value attitude to the world (Kraevsky and Lerner, 1981). The need to address just this theory when designing the content of education for sustainable development is indicated in a number of studies (Dzyatkovskaya and Zakhlebnyi, 2016).

A school subject is a didactically adapted system of scientific knowledge about the world and a person's place in it. The volume of scientific knowledge is growing exponentially, therefore knowledge is the most dynamic element of the system.

In the framework of the study, we consider the experience of an emotional-value attitude to the world as the most constant, long-forming and system-forming element of the knowledge system. We consider the formation of an emotional-value component by means of biology as one of the strategic goals of education for sustainable development.

The experience of an emotional-value attitude to the world involves the formation a schoolchild's set of value ideas that guide him in the present and future. At the same time, a personal experience of an emotional-value attitude to the world is formed (Knyazeva, 2015).

The value ideas that make up the personal experience act as regulators of behaviour and factors in the choice of a particular model of action. At the same time, they are the result of a person's assimilation of social and cultural-historical experience.

The selection of the content of a school subject aimed at the formation of value ideas among schoolchildren is based on the value potential of biological science: its cultural and historical component (Knyazeva, 2015), current and future prospects for the development of not only basic science, but science as a whole as part of culture.

The transformation of the value potential of the subject into the value ideas of students occurs with the direct participation of the teacher, who acts as an intermediary between the content of the subject and the emotional and value sphere of the student.

The process has a subjective colouring, because it is based, firstly, on the teacher's understanding of the value meanings of the educational process in general and the educational process in biology in particular, and secondly, on the teacher's personal value ideas.

At different stages of ontogenesis, different values have unequal relevance, which is due to a change in leading human activities.

The chronological principle of constructing a system of values is that values of an earlier age acquire a subordinate position with respect to values of a later period (Sevostianov and Gainanova, 2011).

In the context of science education for sustainable development, such a change has other reasons – there is a constant change in the substantial and process content of academic subjects. These changes are caused not only by regular age-related changes in the cognitive activity of students and the concentration of

the subject content around generalizations of science in high school compared with the main school in one cycle, but also by a change in the approaches to the selection and structuring of educational content from cycle to cycle in historical terms.

Within the framework of education for sustainable development, the choice of the "cognitive" component of the content of education is an obligatory stage, since it helps to prevent the blurring of its subject and its transformation into simple information about the problems of sustainable development (Dzyatkovskaya and Zakhlebnyi, 2016).

In 2019, we conducted a study to study the majority structure of values formed by means of biology in basic and high school. The respondents were students – future biology teachers.

The study included theoretical and experimental stages.

The theoretical stage was aimed at solving the following problems:

1) to distinguish between the categories of "value", "value representations of the individual", "value potential of the subject", "value potential of basic science";
2) to differentiate the value representations of a personality according to the subjects of the educational process into "value representations of a student" and "value representations of a teacher";
3) to simulate the process of forming value ideas of students in the framework of the subject.

Methods used at the theoretical stage: analysis of scientific publications concerning formation of students' value ideas, according to the methodology for evaluating the value ideas of an individual.

For the experimental stage, we developed a poll-questionnaire. It included questions to study respondents' attitudes to 11 value categories that belong to two types (Rokeach, 1979): terminal (life, health, beauty, nature, equality) and instrumental values (kindness, striving for truth, freedom, perseverance, justice, creative an approach).

The questionnaire was designed for future biology teachers, whom we consider as a connecting element in the process of transforming the value potential of a subject into value ideas of students. In 2019, 40 students of the Pedagogical University of the specialty "Biology" took part in the survey. The questionnaire was aimed at solving such problems:

1) to establish the majority structure of the school biology course values (poll questions 1, 2, 3, 7, 8, 9);
2) to establish the majority structure of the value representations of future biology teachers (poll questions 4, 5, 6).

We adhere to the approach according to which value is "a firm conviction that a certain mode of behaviour or the ultimate goal of existence is preferable from a personal or social point of view than the opposite way of behaviour, or the ultimate goal of existence" (Leontiev, 1998).

Values have a hierarchical nature, because, unlike norms, they are a system: a personal system of values, a system of values of a society, a professional system of values (Sevostianov and Gainanova, 2011). The hierarchical structure of values also determines that the value system itself should reflect the general properties of hierarchical systems (Sevostianov and Gainanova, 2011). Speaking about the concrete-applied significance of axiology in the school educational process, and therefore about the concrete embodiment of the idea of sustainable development in education, it is important to solve a number of issues. For example, should a system of values formed by means of a subject of biology, chemistry, ecology reflect the properties of biological, chemical, ecological systems? Or should one proceed from such general properties of systems as integrity, emergence, subordination, reliability, adaptability, etc., irrespective of subject matter?

In the latter case, the value systems formed in the educational process when studying different educational subjects of the natural science cycle are characterized by the same properties with different content. More specifically, the problem can be formulated as follows: are terminal values such as life, health, nature - the values formed by the means of all subjects of the natural science cycle or only biology?

The study of this question will give an answer about what values, value ideas should be formed in the light of implementation of the idea of sustainable development in education when studying the subjects of the natural science cycle individually and as a whole. Let us note that there are successes in finding the answer to this question. Education for sustainable development should be subject-related (Dzyatkovskaya and Zakhlebnyi, 2016; Ryzhakov, 1999; Ivanova and Osmolovskaya, 2012). Within each subject-oriented invariant (ecologically-centred, economically-centred) a varied content is built taking into account the local educational and cultural context. The subjectivity of education for sustainable development helps to prevent the blurring of topics identified by UNESCO as priority within the main topics of discussion in education for sustainable development (UN Economic and Social Council, 2005).

In the model constructed around the "ecological imperatives" invariant, the personal meanings of the ecological imperative are the system-forming factor in the content of education for sustainable development (Dzyatkovskaya and Zakhlebnyi, 2016).

We found that in literature the concepts of "values", "value orientations", and "value representations" are often confused. The latter are not reducible either to values, as really acting immanent regulators of human activity, or to value orientations, as conscious representations of a subject about his own values.

Value representations of a personality are a complex dynamic category, including its value orientations, value ideals, value stereotypes, value retrospective, etc. (Leontiev, 1998).

The valuable potential of an educational subject is the subject content, which reveals the social and personal significance of the material being studied.

The valuable potential of basic science is the totality of objective knowledge about social and natural reality, the leading motive for which is the need to know nature, rather than gaining control over natural objects (Vlasova, 2014).

In the course of solving the second and third tasks, we came to the conclusion that:

- teacher's value ideas are factors of the formation of students' value ideas;
- formation of teacher's value ideas that are adequate to the modern level of science, society and culture development, is one of the tasks of his professional training;
- the process of forming students' value ideas within the framework of a school subject looks like this: "value potential of basic science" → factors of selecting the content of education → "value potential of a school subject" → "value ideas of a teacher" → "value ideas of a student".

The content and results of a survey conducted at the experimental stage are given below.

1. Do you agree that the content of the subject "Biology" is aimed at the formation of value ideas of students?

   Results: a) clearly "yes" – 63%; b) more likely "yes" than "no" – 28%; c) rather "no" than "yes" – 9%; d) clearly "no" – 0%.

2. Is the content of the subject "Biology" in the basic school, in your opinion, aimed at forming ideas about what values? Arrange them in descending order: kindness, life, health, aspiration for truth, beauty, nature, freedom, equality, perseverance, justice, creativity.

   Results: nature – 86%, life – 74%, health – 74%, beauty – 20%, creativity – 6%, freedom – 6%, kindness – 6%, equality – 3%, striving for truth – 3%, perseverance – 3%, justice – 3%.

3. What values creating is the content of the subject "Biology" in high school, in your opinion, aimed at? Arrange them in descending order (the options are the same as in question number 2).

   Results: health – 54%, life – 49%, perseverance – 46%, nature – 40%, striving for truth – 17%, beauty – 11%, equality – 11%, creativity – 9%, justice – 9%, freedom – 6%, kindness – 3%.

   The results of the answers to questions 2 and 3 are summarized in figures 1, 2 and 3 (dark line – basic school results, light line – high school results).

4. Arrange the values in order of decreasing their priority for yourself (the options are the same as in question No. 2).

   Results: life – health – nature – perseverance – justice – equality – freedom – beauty – kindness – creativity – striving for truth.

5. Select three synonyms for the word "valuable" from the list: expensive, long-awaited, deserved, promising, useful, pleasant, fair.

   Results: expensive – 49%, long-awaited – 31%, well-deserved – 37%, promising – 29%, useful – 60%, pleasant – 20%, fair – 20% (results are presented in figure 4).

6. Rate the following statements (I agree with – the "+" sign, I do not agree with – the "-" sign):

   a) valuable is what is important and useful for me – 86%; b) valuable is what is important and useful for my loved ones – 86%; c) valuable is that which is important and useful for society – 74%; d) valuable is that which is important and useful for nature – 94%.

So, in 2019 we came to the following conclusions:

1. In the basic school, the content of school biology is primarily aimed at the formation of ideas about terminal values – "life", "health", "nature".
2. In high school, the content of the subject is primarily aimed at the formation of ideas about terminal values – "life", "health", as well as instrumental value – "perseverance".
3. In the biology course of high school, as compared with the basic one, the orientation toward the formation of ideas about the terminal values of "life", "health", and "nature" decreases.
4. In high school, the focus is on the formation of ideas about instrumental values "striving for truth" and "perseverance."

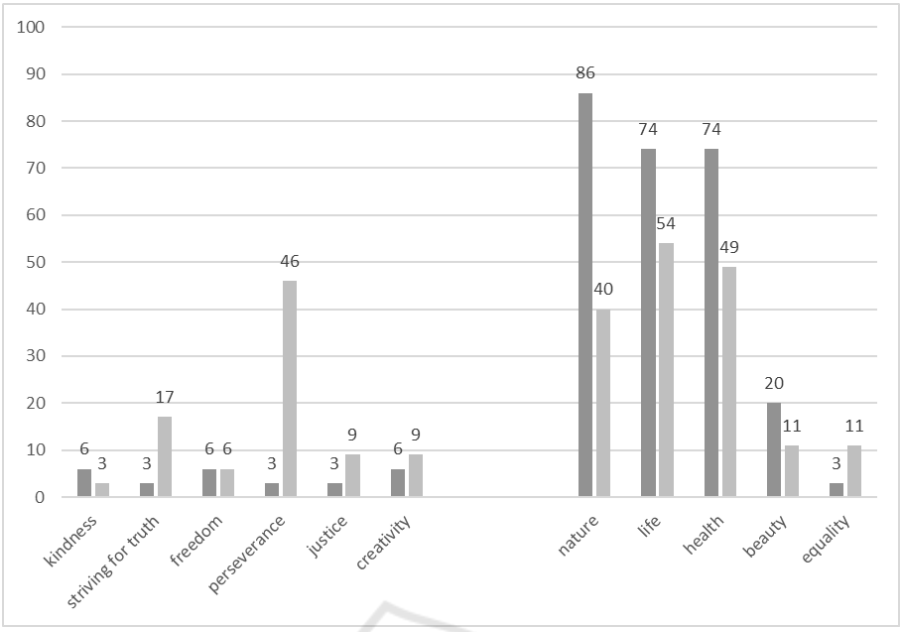

Figure 1: General results on the selection of values of a school biology course.

Figure 2: Majority system of terminal values.

5. In general, the school biology course is more focused on the formation of ideas about terminal values than instrumental ones.
6. The results can be considered as confirmation of the chronological principle of building a system of values in ontogenesis.
7. In the majority structure of value ideas of future biology teachers, the three leaders are orientations towards terminal values: life, health, nature.

In the course of an experimental study, it was found that such instrumental values as a creative approach and the aspiration for truth do not find a worthy representation in the majority list of value ideas of respondents.

On the one hand, such a result is relevant, on the other hand, it is not very charitable from the point of view of a positive assessment of the readiness of future teachers for professional activities for the implementation of sustainable development ideas in biology education.

The majority structure of the selected synonymous

Figure 3: Majority system of instrumental value.

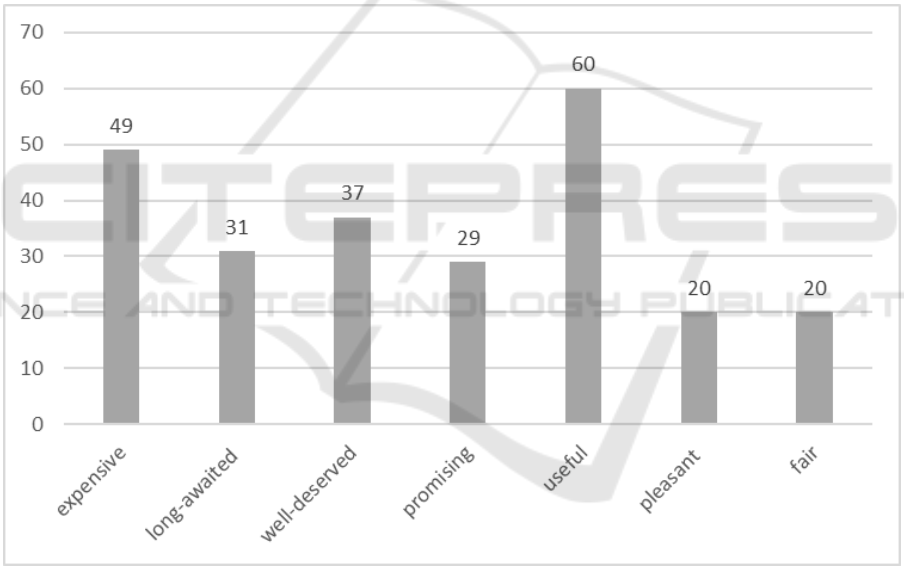

Figure 4: The respondents' choice of synonyms for the word "valuable".

terms (task 5) demonstrates that the respondents attribute to values the following: firstly, something having a utilitarian focus (valuable – useful), secondly, something which is expressed in significant material equivalent, and thirdly, something which involves the application of certain efforts.

We saw further directions of research in 2019 in the following (Komarova and Starova, 2020):

- establishing the causes of the revealed differences between the value potential of the subject "Biology" and the value ideas of the participants in the educational process, that is, between their declared and real values;
- elucidation of the nature of reflection of differences in the fulfilment by teachers of biology of professional activities in the framework of education for sustainable development;
- the study of the ratio of declared and real values (value ideas) of students;
- study of the microstructure of personality value representations of a biology teacher and a student studying biology (value orientations, value stereotypes, value ideals, etc.);
- modelling the process of value ideas formation of a biology teacher as a factor in the formation of

students' value ideas solving the problems of education for sustainable development;

- modelling the process of forming value representations of students' personality by means of school biology in the framework of education for sustainable development.

In 2020, humanity is facing a biological challenge. The coronavirus pandemic and ways to overcome it immediately found a response in the global scientific community. Prioritizing medical care during a pandemic, restricting rights and freedoms, developing vaccines, conducting clinical trials, introducing new vaccine registration standards and their widespread use in a pandemic (Emanuel et al., 2020; Fidler, 2020), principles of distribution of vaccines between countries and population groups, risks associated with vaccination, social consequences ... These and many other issues are united by one thing – the bioethical component: risks, information, consent, choice, fairness, voluntariness.

And so, in October 2020, another significant event took place in the natural science world, which stirred up the scientific community. We are talking about the award of the Nobel Prize in Chemistry in 2020 (www.nobelprize.org, 2021). "Emmanuelle Charpentier and Jennifer A. Doudna have discovered one of gene technology's sharpest tools: the CRISPR / Cas9 genetic scissors. Using these, researchers can change the DNA of animals, plants and microorganisms with extremely high precision. This technology has had a revolutionary impact on the life sciences, is contributing to new cancer therapies and may make the dream of curing inherited diseases come true" (www.nobelprize.org, 2020).

This discovery in 2012 was a breakthrough not only in the natural sciences industry (Meloni, 2014). According to scientists, it turned the sphere of humanitarian knowledge, updated a number of issues related to the identification of the human essence (Lukov, 2017; Buynyakova, 2017, 2019; Allhoff et al., 2009; Masci, 2020).

The discovery of the mechanism of genetic scissors and the study of its use for editing the human genome will force us to take a fresh look at the significance in the life of each individual and society as a whole of the terminal values "life", "health", "equality", instrumental values "kindness", "freedom", "justice". We assume that the issues of good, justice, equality and the opposite issues of evil, unjustified, infringement of rights will be updated with renewed vigor in the public discussion of the prospects and consequences of editing the human genome. In light of this, the discussion of the possibilities and consequences of "human improvement" will take on new turns. In the context of the issue of the value potential of biological education, we are interested in the bioethical component of the problem of human enhancement. Editing the human genome will make it possible to modify the biological essence of a person, but is this the general goal that humanity should strive for? What are the risks and benefits of further research in this area? Does the benefit outweigh the risk, is the risk justified? Will the biotechnological enhancement not entail a leveling of the social component of the human essence, will not the uniqueness of the human personality as a whole be reduced to nothing? Will the goals and values of human life change and how?

These and similar questions naturally arise both in philistine circles and among representatives of the scientific community: biologists, philosophers, sociologists. They become the subject of heated discussions, and require the earliest possible discussion and solution.

It should be noted that the study of the problem of people's attitudes towards the possibility of biotechnological enhancement is not new. The results of a study of public opinion using focus groups on such areas of enhancement as genome editing, chipping, and the use of artificial blood obtained in 2016 are very interesting (Rainie et al., 2016; Funk et al., 2016). In general, the results of the survey in 2016 showed a negative attitude of respondents to the possibilities of human improvement in all three areas.

So, 2020 is the year of the beginning of a new wave of discussion of the bioethical component of science, biological science. It is natural that social and scientific events of 2020 cannot but affect different spheres of public life. They find reflection in the revision, clarification, transformation of the previous goals and value meanings of both the sphere of education and subjective values.

Among the promising directions in the study of the value orientations of biological education voiced earlier in the article were named:

- study of the microstructure of value representations of the personality of a biology teacher;
- modeling of the process of forming value ideas of a biology teacher.

What has been done in this direction, what results have been obtained and what conclusions have been formulated for further work in the direction of studying the content and transformation of the value meanings of biological education?

In 2020, the study was conducted on the basis of the Immanuel Kant Baltic Federal University.

2 TECHNIQUE AND METHODS

At the Immanuel Kant Baltic Federal University, preparation of students for professional pedagogical activity is carried out within the framework of the study of an elective pedagogical module. The study of the module according to the curriculum takes place in the 5th or 6th semester for students of the specialty "Biology". The content of the module is limited by the narrow framework of study time (12 hours of lectures and 12 hours of practical training). This is the reason that the study of issues of bioethical content, which we consider extremely important for the formation of value concepts of future teachers of biology, we moved into the content of other academic subjects: the discipline "Fundamentals of Theoretical Biology" (72 hours) and "Bioethics" (60 hours). The number of academic hours for the study of these disciplines is much more than for the study of the pedagogical module. Therefore, the axiological foundations of biological science and education, their bioethical component are extensively presented by us in these courses.

In the first half of 2020/2021, within the 9th semester for 4th year students of the specialty "Biology" in the 7th semester, the course "Fundamentals of Theoretical Biology" was delivered. At the same time, the course "Fundamentals of Bioethics" was taught for 5th year students of the specialty "Biotechnology and Bioengineering". The course content included bioethical issues relevant in 2020 for the development of biological science. After studying the above disciplines, the students of the Institute of Living Systems were invited to take part in the survey "Biology and Ethics of Human Improvement". The survey was also attended by 1st year students, for whom disciplines with bioethical content were not read in the 1st semester.

The survey form is online using Google Forms templates.

The purpose of the survey is to identify among the student youth, who have chosen natural (chemical and biological) sciences as the sphere of their professional interests, a value attitude towards the development of modern biology using the example of the problem of human biotechnological enhancement.

Tasks of the survey:

- to identify students' understanding of the essence of the bioethical component of scientific research (using the example of the problem of human biotechnological enhancement);
- to establish the necessity, format and topics of discussion of modern bioethical problems.

80 students took part in the survey (57 1st year students, specialty "Biology", "Chemistry", "Biotechnology and Bioengineering", 9 5th year students, specialty "Biotechnology and Bioengineering", 14 4th year students, specialty "Biology"). Closed and open questions were proposed.

3 RESULTS

The content and results of the survey are presented below.

1. Do you think that human improvement can be a modern biotechnological project?

   Variants of answer: unequivocally "yes", unequivocally "no", rather "yes" than "no", rather "no" than "yes", I find it difficult to answer, my own version. The results of the answer are shown in figure 5.

The results show that 5th year students are more cautious in their assessment of considering human improvement procedures as a biotechnology project. At the same time, caution is manifested not only in a decrease in the choice of a sharply positive answer (22.2% versus 43.9% and 50% in the other groups). Characterized by the complete absence of a choice of a sharply negative answer, and a weakly negative answer (0% versus 10.5% and 7.1% in the other groups).

The results of the answers of the 1st and 4th year groups are close in values.

The reason for the difference in answers between the 1st, 4th and 5th courses may be in the specifics of the specialties for which students are trained. The 5th year students of the specialty "Bioengineering and Bioinformatics" approach the reality of "improving" a person from a utilitarian and practical point of view. Students of the specialty "Biology", not having sufficient professional knowledge, more easily assess the potential of human enhancement.

In general, the majority of the respondents consider human enhancement as a possible modern biotechnological project.

2. Do you consider it possible from an ethical point of view to intervene in the human genome, edit it?

   Answer options see in item 1.

The results of answering this question allow us to state that for students of the specialty "Bioengineering and Biotechnology" it is more acceptable from an ethical point of view than for students of the specialty "Biology", is the possibility of editing the human genome. It can be assumed that this result is due to the same reason that was named in the previous question. Future biotechnologists and bioengineers consider the human genome as an object for instrumental impact due to the peculiarities of their professional training.

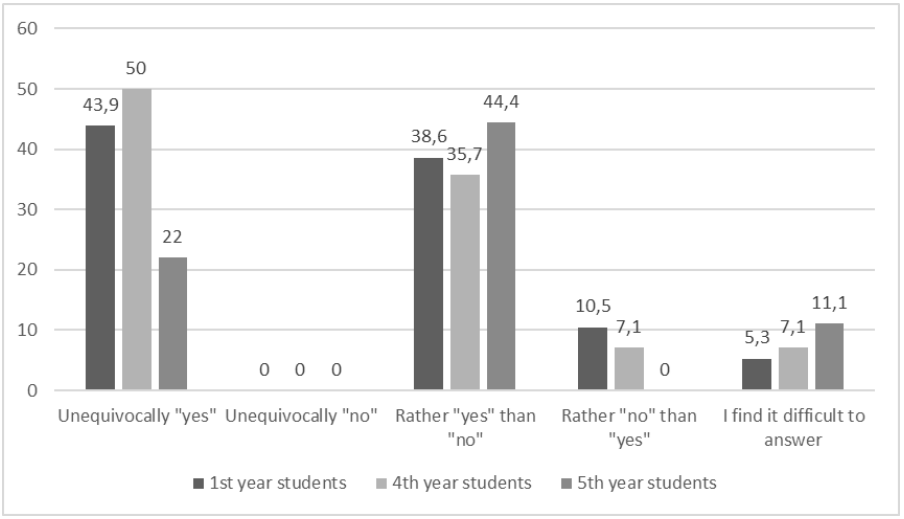

Figure 5: Results of the answer to the question “Do you think that human improvement can be a modern biotechnological project?”.

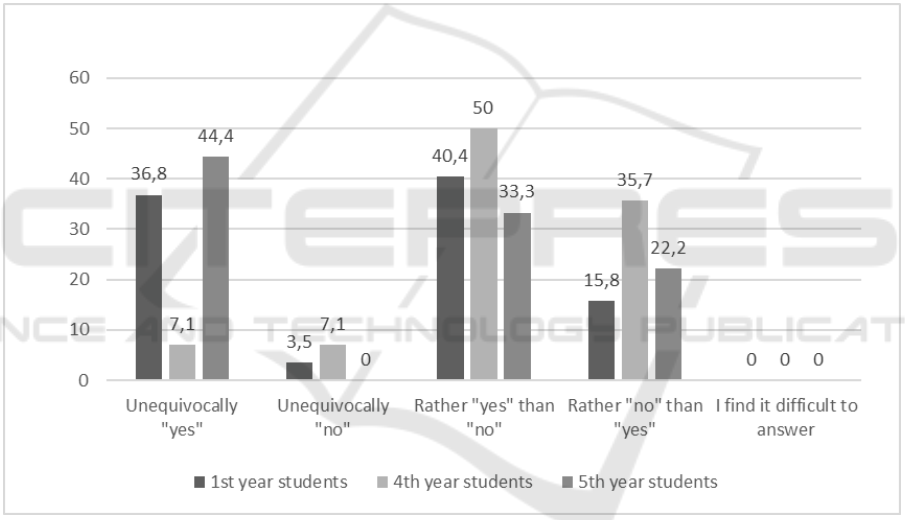

Figure 6: Results of the answer to the question “Do you consider it possible from an ethical point of view to intervene in the human genome, edit it?”.

The results in groups of biology students turned out to be very interesting. So, for 1st year students, the answers with a sharply positive answer and a weakly positive answer in total are the same as for biotechnology students (36.8% and 40.4% for biologists and 44.4% and 33.3% for biotechnologists). For fourth-year biologists, the share of sharply positive answers is only 7.1% (versus 36.8% for first-year students and 44.4% for fifth-year students). The total amount of negative answers for fourth-year biologists is 42.8% (sharply negative 7.1%, slightly negative 35.7%) versus the total amount of negative answers among first-year students – 19.3% (sharply negative 3.5%, weakly negative 15.8%) and 5th year students 22.2% (sharply negative 0%, slightly negative 22.2%).

A possible reason may be that for the 4th year students, the bioethics course was not read until the moment of the questionnaire, in contrast to the 5th year students. But for the 4th year students the course “Foundations of Theoretical Biology” was taught, the content of which laid the foundations of modern bioethical knowledge. In addition, the methods of practical work with 4th year students included holding round tables in full-time format, in contrast to the defense of project work in an online format by 5th year students. Also, for 4th year students, such a form of work was introduced as writing an essay on bioethical topics and its defense. The form of intermediate control for 4th year students in mastering

the discipline “Foundations of Theoretical Biology” was written control papers with open questions of a debatable nature. For 5th year students, intermediate control was not carried out.

In parallel with the above explanation, the problem arises of explaining the results for 1st year students. We believe that this issue requires further study.

We assume that the study of the course “Foundations of Theoretical Biology” has a positive effect on the formation of elements of bioethical knowledge of students – future biologists. This issue also requires further study, especially considering the fact that the same students will have to study the course “Bioethics” in the 8th semester, in an amount of hours that is 2 times the volume of the discipline “Fundamentals of Bioethics” for 5th year students of the specialty “Biotechnology and Bioengineering”.

3. Do you think that interference with the human genome is dangerous?

Variants of answer: yes, no, I find it difficult to answer.

The results of the answer to this question demonstrate the significant caution of the respondents regarding the safety of human biotechnological enhancement. It is noteworthy that 5th year biotechnology students are most cautious. 1st year students are the most optimistic. How do we explain these results? We assume that the reason is the lack of experience in professional biological training, the immaturity of the position on ambiguous scientific problems, insufficiently formed scientific critical thinking.

4. What kind of danger can occur when trying to biotechnological enhancement of a person? There are several options to choose from.
   - A person’s loss of his self-sufficiency as a natural phenomenon;
   - Difficultly predictable biological consequences;
   - Aggravation of ethical problems, for example, associated with limited access to the genome improvement procedure - a service only for the rich;
   - The problem of elitism of “improved” genomes in comparison with natural genomes, increasing social inequality;
   - Rough interference with natural mechanisms developed over millions of years will change the course of the evolutionary process and disrupt its course;
   - No dangers, only advantages.

The results of the answer to the question differ in the groups of students. For 1st and 5th year students, the greatest danger is difficultly predicted biological consequences. For 4th year students, the greatest danger is problems of possible social inequality and the threat of the emergence of elitism of “improved” genomes. For 1st and 5th year students, such a danger as a person’s loss of his self-sufficiency as a natural phenomenon is in last place. For 4th year students, this danger is very significant, it is in second place in the choice.

The reason for this difference, we consider the work with students to study the discipline “Foundations of Theoretical Biology”, as mentioned above. The content of the discipline provided for the study of the topic of bioethical orientation and forms of work, involving the conduct of a free discussion, expressing one’s own position on the issue of discussion. Among the practical forms of studying the discipline “Fundamentals of Theoretical Biology” listed above in paragraph 2, we used such a form of extracurricular work as watching feature films – products of world cinema – with a pronounced bioethical orientation, followed by a collective discussion of controversial issues. The study of the effectiveness of such forms of work in the formation of students’ value ideas, in increasing their bioethical literacy and responsibility requires further work. We consider it premature to talk about final results.

5. Do you think that the problem of biotechnological enhancement should be transparent for public discussion?

Variants of answer: yes, no, I find it difficult to answer.

According to the results of the questionnaire, more than 70% of all respondents in each of the groups of students are inclined to open public discussion of the problems of biotechnological enhancement. We explain the differences in the choice of a negative answer by the fact that biotechnology students, due to their professional training, are more inclined to consider the human genome as an object for instrumental influence. In this case, as for any other biological object with which instrumental actions are carried out, discussions are permissible only in a narrow circle of professionals who have education and experience in carrying out the appropriate manipulations.

It is noteworthy that only 1st year students do not consider biotechnological enhancement as a potentially dangerous procedure, do not see any negative consequences of its application. A possible explanation can be considered the same increase in the volume of special knowledge among 4th and 5th year

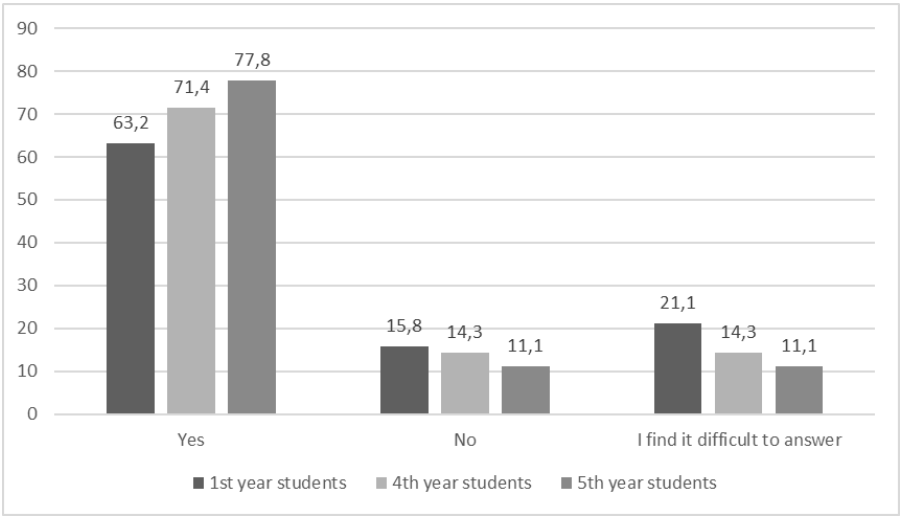

Figure 7: Results of the answer to the question "Do you think that interference with the human genome is dangerous?".

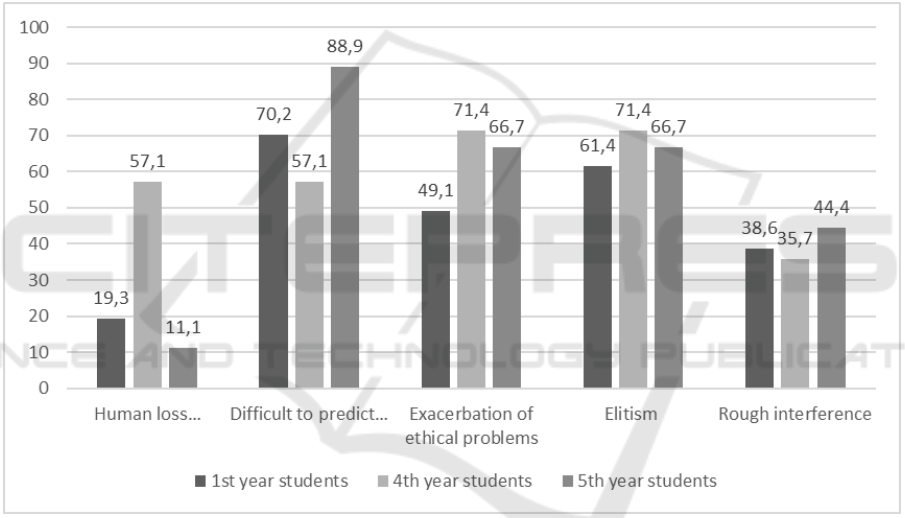

Figure 8: Results of the answer to the question "What kind of danger can occur when trying to biotechnological enhancement of a person?".

students, the greater criticality and alternativeness of their professional thinking.

6. In your opinion, the possibility of genome editing is:
   - Solving many problems that were impossible to solve earlier (creating resistant genomes to infections, senile diseases, malignant tumors);
   - One of the mechanisms for providing access to the resources and benefits of mankind to a small oligarchy;
   - The reason to receive the Nobel Prize, but in fact it will not come to practical use.

The results of the answer to question 6 demonstrate the confidence of the respondents that genome editing will provide an opportunity to solve a number of problems in which biological science was previously powerless. However, 4th year students in their answers also speak out in favor of the fact that such manipulation will increase inequality between people, lead to stratification of society and can cause social conflicts. The results of 28.6% are indicative enough to be taken into account in assessing the formation of students' understanding of the value potential of biological science and modern scientific achievements. We assume that the reasons for the differences in the group of 4th year students are similar to those named in paragraphs 2, 4.

7. Would you like to know more information about human improvement through biotechnology?

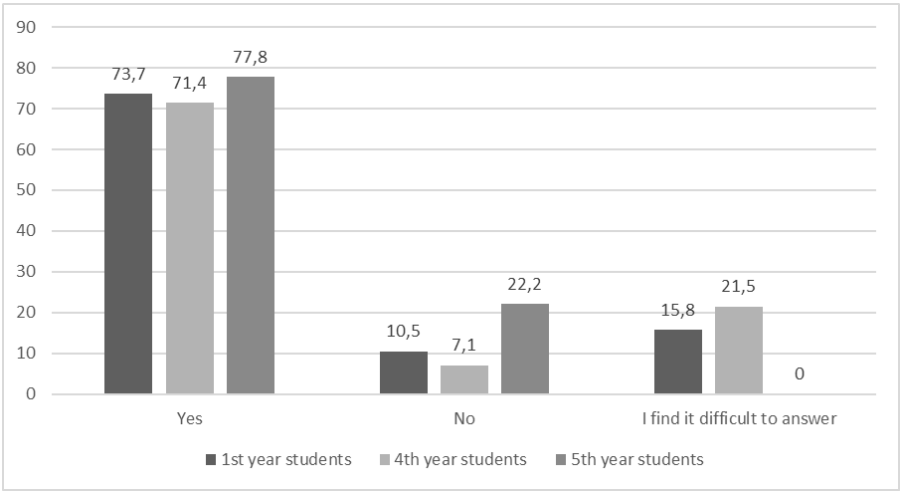

Figure 9: Results of the answer to the question "Do you think that the problem of biotechnological enhancement should be transparent for public discussion?".

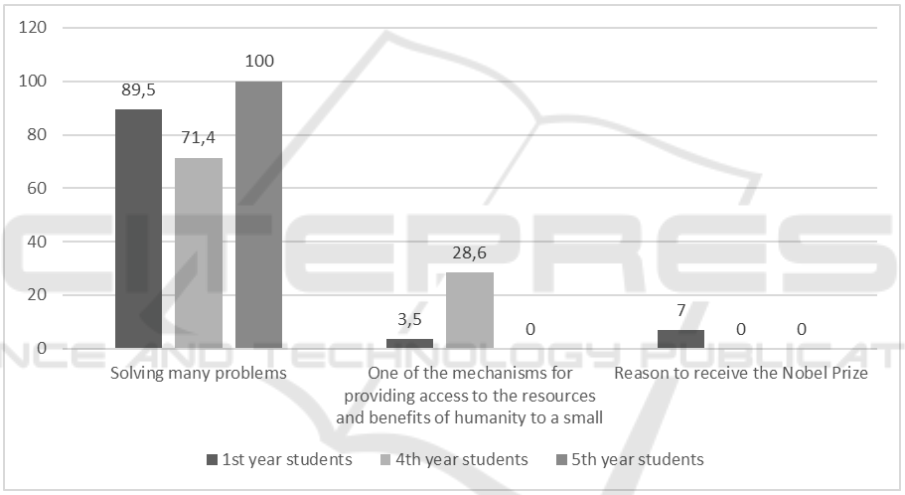

Figure 10: Results of the answer to the question "In your opinion, the possibility of genome editing is?".

- Yes;
- No.

Students of all groups are unambiguous in their desire to learn more about the possibilities of biotechnological enhancement. However, the results show that the group of 4th year students has the largest number of answers with negative choice in comparison with other groups. We assume that the reasons for this difference are similar to those named in paragraphs 2, 4.

8. What kind of information would be interesting for you?
   - The history of the human enhancement;
   - Ethical issues related to the improvement of the genome;
   - Mechanisms and types of enhancement;
   - Risks of enhancement.

For students of all groups, the most interesting questions are related to risks, mechanisms and types of enhancement. The least interesting topics are related to the history of human enhancement. We can explain the results obtained by the fact that it is inherent in student youth to think in terms of "here and now", to receive actual, not retrospective knowledge.

9. In what form would you like to learn more about enhancement?
   - Lecture;
   - Round table;
   - Webinar;
   - Independent reading of specialized literature.

The results of the answer to this question allow us to state the presence of a tendency: from 1 to 5

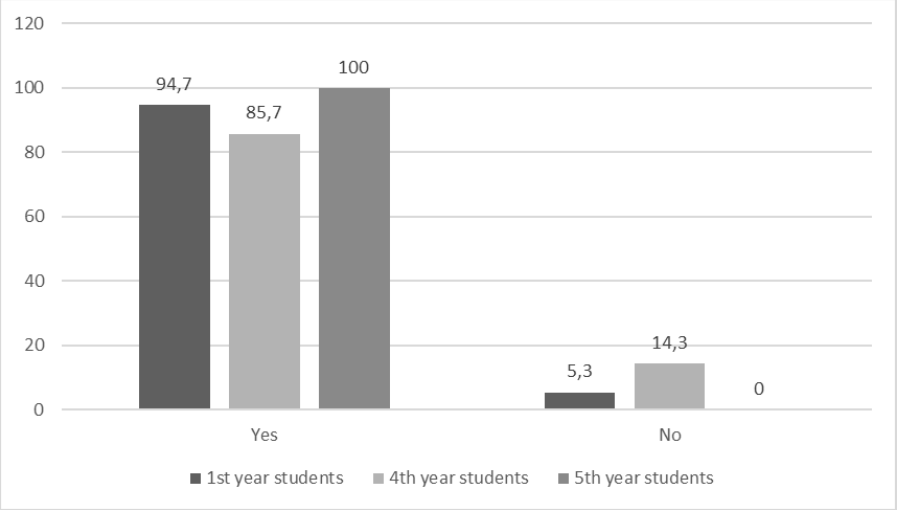

Figure 11: Results of the answer to the question "Would you like to know more information about human improvement through biotechnology?".

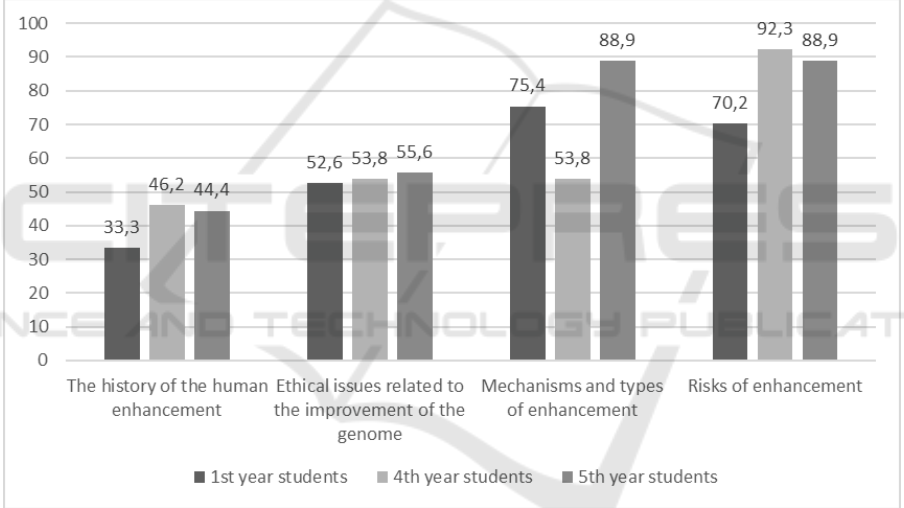

Figure 12: Results of the answer to the question "What kind of information would be interesting for you?".

courses, the importance of monologue teaching methods decreases and the importance of dialogic methods increases when studying issues of bioethical content, in particular, concerning biotechnological enhancement.

We assume that such results can be associated with the use of active teaching methods – round tables, defense of design works, presentation of essays in the study of the discipline "Fundamentals of Theoretical Biology" in the 4th year and "Fundamentals of Bioethics" in the 5th year.

We assume that the redistribution of the types of classroom work with students towards an increase in the number of hours for the practical part by reducing the lecture part of the course can be effective in shaping the value concepts of students, in increasing their bioethical literacy and responsibility.

10. Name three words that come to mind when you say "human improvement":

The results of the answer to this question are presented in the table 1. Note that in the table in bold those words are highlighted that within each group occurred 2 or more times. In addition, we considered the same root words as identical (for example, new and novelty, cyborg and cyborgization, etc.).

The results of the answers to this question are such that in the group of 1st year students there is a maximum number of single-root words used – 21.8% (in comparison with the group of 4th year students – 3.0%, and 5th year – 0%).

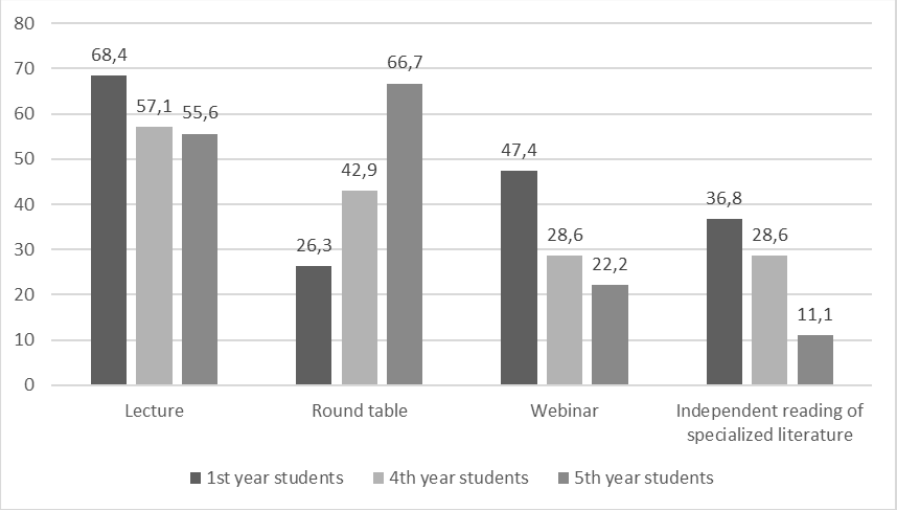

Figure 13: Results of the answer to the question “In what form would you like to learn more about enhancement?”.

Also, among all the answers of students from each of the groups, we isolated words-associations with a uniquely negative content (for example, social stratification, break, vice, etc.). These association words are shown in italics in the table.

As a result, we received the following results: in the group of 1st year students the least number of words with negative associative meaning (8%), among 4th year and 5th year students – 18.8% and 12.5%, respectively.

We consider this result not accidental. The reasons mentioned in clauses 2 and 4 can serve as explanations.

At the same time, the results obtained on the last question will be useful for a deeper lexical and semantic analysis of the language units used by students. We assume that this will provide interesting data on the formation of an associative image in people regarding scientific innovations, in our case, on the possibility of genome editing and human biotechnological enhancement.

We attribute to the difficulties of the conducted research:

- participation in the experiment for one group of students from the 4th and 5th year of the specialty “Biology”, “Biotechnology and Bioengineering”;
- no repetition in experimental learning (no technical replication). It will be conditionally possible to theoretically implement it only in the next academic year, comparing the actual results for today with the future ones;
- the implementation of the previous point is unlikely to lead to reliable results, since the growth rates of scientific biological knowledge are high. To predict how the other spheres of public life interconnected with the scientific sphere will change seems at the moment an almost impossible task;
- attempts to carry out quantitative account of the cash generated by the person values are associated with methodological difficulties, since the category of “value” – it is still the category of quality, not quantity.

4 CONCLUSIONS

The conclusions we formulated as a result of our research at the end of 2020:

- the interviewed students recognize the importance of the bioethical component of modern scientific developments in biology;
- the majority of the students surveyed express their readiness and desire to discuss issues of the bioethical nature of scientific innovations. This makes it possible to assume the possibility of a positive influence on the formation of terminal and instrumental values of students through appropriate training;
- introduction into the curriculum of training students of biological specialties of the discipline “Fundamentals of theoretical biology” with the study of issues of bioethical content is advisable. The positions of students who studied this discipline (4th year) on a number of issues of bioethical content differed from those who did not study the discipline (1st year and 5th year). It should be

Table 1: Results of the answer to the question "Name three words that come to mind when you say "human improvement?".

Group of 1st year students	**Immortality**, business, bioengineering, biology, biotechnology, biohacking, bioethics, the fight against cancer cells, **the future**, eternity, power, **perhaps only education**, **opportunities**, necessity, endurance, **genetics**, genetically ideal people, genetic diseases, **genius**, genetic engineering, genome, money, kindness, **longevity**, eugenics, *universal soldier*, *social stratification*, life, **health**, perfection, danger, *emperor*, **cyborg**, *colonization*, treatment, longevity, better life, mechanism, dream, brain-computer interfaces, **science**, inequality, **novelty**, morality, education, opportunities, **danger**, perfection, absence of diseases, increase of mental abilities, benefit, help, *vice*, posthumanism, revolution, limits, problem, **progress**, prosthesis, processor, **development**, adaptation, *superiority*, *break*, solution, risk, **self-development**, superintelligence, increased life span, **superman**, **superintelligence**, **strength**, death, **perfection**, ability, old age, with perseverance, happiness, transhumanism, mind, civilization, chipping, chips, **evolution**, ecology, experiment
Group of 4th year students	Safety, biotechnology, neurointerface, diseases, **future**, HIV, power, opportunities, longevity, eugenics, ideality, change, immunity, *end of the world*, *I will not see*, *inaccessibility*, victory over hereditary diseases, the appearance of "superpowers" in a person, *obstacle*, progress, prosthesis, *against nature*, development, *regression*, editing the human genome, birth, complexity, improvement, technology, stability, physical condition, perfection, ethics
Group of 5th year students	CRISPR/Cas, adaptation, upgrade, botox, genome, eugenics, cure, liposuction, *not now*, useful, risks, self-development, superman, improvement, *what will God say?*, enhancement

noted that the students who studied were more inclined to understand the social consequences and risks of biological innovations than others. We explain this by the content of the discipline, which considered the history of biology, the direction of development of modern branches of biology, as well as the forms of education used. This was mentioned above when explaining the results of answers to individual questions;

- to assess the level of formation of terminal and instrumental values among students of biological specialties seems to us a global large-scale issue. It is unambiguous that it is impossible and impractical to make a quantitative assessment of the formed values. The need for a qualitative assessment rests on the question of whether the values formed through the educational process should differ among students of biological specialties. In other words, should different terminal and instrumental values be formed in students – future biologists and students – future teachers?

5 OUTLOOK

Summing up, we note that our further research in the direction of the value meanings of biological education posed more questions than answered. We can only assert unequivocally that the training of future biologists, including those who will continue their professional activities in the field of education, must include a thorough bioethical training. It will allow future biologists-scientists and future biology teachers to navigate the present and future world, to make informed choices, and make informed decisions.

REFERENCES

Abdurahmanov, G. M., Monakhova, G. A., Murzakanova, L. Z., Abdurahmanova, L. G., Bagomaev, A. A., and Alieva, Z. A. (2010). Education for the stable development (analysis, scientific basis, world experience). *South of Russia: ecology, development*, 5(2):251–266.

Allhoff, F., Lin, P., and J. Moor and., J. W. (2009). Ethics of Human Enhancement: 25 Questions & Answers. Technical report, US National Science Foundation. http://ethics.calpoly.edu/NSF_report.pdf.

Buynyakova, I. S. (2017). Philosophical and ethical issues of biotechnological "human enhancement". *Logos et praxis*, 16(3):49–55.

Buynyakova, I. S. (2019). Biotechnologies of human enhancement in the paradigm of the transhumanistic discourse. *Belgorod State University Scientific Bulletin*, 44(2):294–304.

Dzyatkovskaya, E. N. and Zakhlebnyi, A. N. (2016). Does education for sustainable development have its own object of cognition? *Vestnik of Buryat State Univer-*

sity, (4):3–11. http://journals.bsu.ru/content/articles/232.pdf.

Emanuel, E. J., Persad, G., Kern, A., Buchanan, A., Fabre, C., Halliday, D., Heath, J., Herzog, L., Leland, R. J., Lemango, E. T., Luna, F., McCoy, M. S., Norheim, O. F., Ottersen, T., Schaefer, G. O., Tan, K.-C., Wellman, C. H., Wolff, J., and Richardson, H. S. (2020). An ethical framework for global vaccine allocation. *Science*, 369(6509):1309–1312. https://science.sciencemag.org/content/369/6509/1309.

Fidler, D. P. (2020). Vaccine nationalism's politics. *Science*, 369(6505):749–749. https://science.sciencemag.org/content/369/6505/749.

Funk, C., Kennedy, B., and Sciupac, E. P. (2016). U.S. Public Wary of Biomedical Technologies to 'Enhance' Human Abilities.

Grachev, V. A., Ursul, I. V., Ursul, A. D., Ursul, T. A., and Andreev, A. I. (2017). *Obrazovanie dlya ustojchivogo razvitiya v Rossii: problemy i perspektivy (ekspertno-analiticheskij otchet) (Education for Sustainable Development in Russia: Problems and Prospects (Expert and Analytical Report)*. Moskovskaia redaktciia izdatelstva "Uchitel", Izdatelstvo Moskovskogo universiteta, Moscow.

Ivanova, E. O. and Osmolovskaya, I. M., editors (2012). *Predmetnost obucheniya v shkolnom obrazovatelnom processe (The subject of instruction in the school educational process)*. Moscow.

Knyazeva, H. (2015). Innovative complexity: methodology of organization of complex adaptive and network structures. *Philosophy of Science and Technology*, 20(2):50–69. https://iphras.ru/uplfile/root/biblio/ps/ps20_2/50-69.pdf.

Komarova, E. and Starova, T. (2020). Majority values of school biological education in the context of education for sustainable development. *E3S Web of Conferences*, 166:10029.

Koryakina, N. I. (2012). Education for sustanable development: Models and strategies of implementation. *Siberian Pedagogical Journal*, (6):131–134.

Kraevsky, V. and Lerner, I., editors (1981). *Teoreticheskie osnovy soderzhaniya obshchego srednego obrazovaniya (Theoretical foundations of the content of general secondary education)*. Moscow.

Leontiev, D. A. (1998). Tcennostnye predstavleniia v individualnom i gruppovom soznanii: vidy, determinanty i izmeneniia vo vremeni. *Psikhologicheskoe obozrenie*, (1):13–25.

Lukov, V. A. (2017). Human enhancement projects: What do russian young people think of the need for them and of their consequences? *Znanie. Ponimanie. Umenie*, 0(4). https://journals.mosgu.ru/zpu/article/view/610.

Masci, D. (2020). Human Enhancement. The Scientific and Ethical Dimensions of Striving for Perfection. https://tinyurl.com/jpk3f6r8.

Meloni, M. (2014). Biology without biologism: Social theory in a postgenomic age. *Sociology*, 48(4):731–746.

Rainie, L., Hefferon, M., Sciupac, E. P., and Anderson, M. (2016). American Voices on Ways Human Enhancement Could Shape Our Future. https://tinyurl.com/33e4ajck.

Rokeach, M., editor (1979). *Understanding Human Values: Individual and Societal*. The Free Press, New York.

Ryzhakov, M. V. (1999). *Teoreticheskie osnovy razrabotki gosudarstvennogo standarta obshchego srednego obrazovaniia*. D.sc. thesis, Institute of General Secondary Education of the Russian Academy of Education.

Sevostianov, D. A. and Gainanova, A. R. (2011). Osobennosti aksiologicheskoi ierarkhii. *Filosofiia nauki*, (3):3–15.

UN Economic and Social Council (2005). The UN Economic Commission for Europe Strategy for Education for Sustainable Development. https://unece.org/fileadmin/DAM/env/documents/2005/cep/ac.13/cep.ac.13.2005.3.rev.1.r.pdf.

UNESCO (2015). Incheon Declaration: Education 2030: Towards Inclusive and Equitable Quality Education and Lifelong Learning for All. https://unesdoc.unesco.org/ark:/48223/pf0000233813.

Vlasova, S. V. (2014). Goals and values of science. *Liberal Arts in Russia*, 3(6):443–456.

WHO (2020). Coronavirus disease (COVID-19) pandemic. https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/novel-coronavirus-2019-ncov.

www.nobelprize.org (2020). Press release: The Nobel Prize in Chemistry 2020. https://www.nobelprize.org/prizes/chemistry/2020/press-release/.

www.nobelprize.org (2021). All Nobel Prizes in Chemistry. https://www.nobelprize.org/prizes/lists/all-nobel-prizes-in-chemistry/.