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## Technology of forming research competence of future biologists: by the example of studying the *genus Agrimonia L.*

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### Abstract

**Relevance.** One of the modern requirements of the development paradigm of modern education is to support the research work of students and their interest in science. The study of biological features of medicinal plants forms them as professionals, developing research competence.

**Purpose.** The research aims to foster students' cognitive, personal, and professional skills while cultivating their research competencies through the exploration of medicinal plants.

**Methodology.** The experimental study, conducted at Kazakh National Women's Pedagogical University, involved 99 third-year students specializing in Biology (0511300-Biology). Among them, 54 students comprised the experimental group, while 45 students formed the control group.

**Results.** In this article the program of the elective discipline "Biological features of medicinal species of *Agrimonia L.*" is compiled, an educational and methodological manual is published and training models of innovative methods are developed. During the experiment, a questionnaire was administered to assess students' biological knowledge across content, motivation, and activity components. The pedagogical experiment's outcomes were consolidated, accompanied by methodical recommendations.

**Conclusions.** The developed program and manual "Biological Features of Medicinal Species of *Agrimonia L.*" enhance biological education for biology students, fostering independent learning. It bolsters expertise among biologists,

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particularly in researching medicinal plants, fostering awareness of their ecological significance and promoting conservation efforts. Experimental validation confirms the effectiveness of this educational approach for biology specialists.

**Keywords:** Agrimonia L.; curriculum; methodology; research; competence; study of medicinal plants.

## Introduction

It is shown that the main purpose of educational programs in the preparation of Bachelor of Education in Biology is the formation of fundamental knowledge, skills and abilities required in professional activities. The preparation of future specialists work on educational programs is important for specialists of higher education institutions in the development of education. The process of preparing future specialists is carried out in accordance with the pedagogical system. The purpose, objectives, content, means, forms, methods and techniques of discipline in the construction of the pedagogical process and tasks are implemented between the teacher and the student [1]. Teacher training depends on the quality of the organization of educational work in higher education institutions. Scientists of Kazakhstan conduct research in domestic science, developing the structure, methodological pedagogical foundations, methods of teaching continuous biological education and upbringing [2]. In interactive learning, the teacher, as before, makes every effort not only to teach, but also together with students to create effective conditions for independent learning [3].

The teacher's readiness to implement innovations in the educational process is related to the knowledge base obtained by the student in the university. The modern specialist in the field of education is a bearer not only of knowledge, but also of pedagogical culture [4; 5].

The provision of quality and comprehensive educational and methodological support of multilevel training of specialists significantly increases the quality and efficiency of training. The main task of the teacher is to prepare high quality teaching materials for the educational process. Modern trends in the development of education require a new approach in the methodological support of the educational process in a pedagogical university [6-9].

As a result of the increased emphasis on the training of subject teachers at institutions of higher education, society is preparing specialists who know their subject well. Today's issue requires specialists who independently acquire new knowledge and strive to be creative. Therefore, there is a need to train teachers who make comprehensive use of innovative methods. Currently, processes are underway to reorganize curricula with a focus on the future qualification of a bachelor's degree [10; 11].

American educators analyzed the literature used in laboratory classes for future biologists, examined the topics of laboratory classes, their purpose and nature of the activities, methodological techniques, and the results of the knowledge obtained. As a result, there was a need to improve the ability to investigate real-world phenomena in laboratories. Through increased cooperation between the teacher and students can develop biological education, conducting practical work with high preparation and focusing on the results and conclusions obtained by the students [12; 13]. A quality and relevant education for

future science teachers requires mandatory research training. Research competence of teachers is a prerequisite for their scientific literacy [14].

The great importance in the formation of research competence of future specialists in biology is an introduction to the biological characteristics of medicinal plants. The centuries-old experience of application in medicine in health care is characterized by the interest in phytopreparations. In recent years there is a growing demand for herbal medicines [15-17]. Medicinal plants are considered the main sources of nutritional supplements, herbal medicines and pharmaceutical preparations [18].

The purpose of the research work is to develop cognitive, personal, business abilities and the formation of research competencies of students in the process of working with medicinal plants. comprehensively introduce the methods of studying the biological characteristics of medicinal forms, to form theoretical knowledge and use the results of research in the educational process.

## Materials and Methods

In the course of the work the program of formation of research competencies of students and teaching materials were developed. When preparing the curriculum and teaching materials the works of US botanists for biologists [19; 20] and review of works of researchers of medicinal plants of Kazakhstan M.K. Kokenov, S.M. Adekenov, A. Iskenderov, N.M. Mukhitdinov, L.M. Grudzinskaya, N.G. Gemedzhieva, E.A Kyrbassova [21-25].

*Agrimonia L.* serves as a foundation for developing the research skills of future biologists and at the same time enriches the field of botany research. Such researches yield valuable insights into the biological characteristics of related dosage forms [26-31].

The experimental work was tested at the Kazakh National Women's Pedagogical University. The experiment involved 99 3-year students of the specialty "0511300-Biology", of which 54 students were in the experimental group, 45 students – in the control group. Experimental work consists of three stages.

The Ascertaining experiment. During the identification stage, an examination of psycho-pedagogical literature was conducted. Textbooks, teaching aids, and methodological literature were analyzed, and problems, tasks, sources, and scientific predictions related to the study of the biological characteristics of medicinal forms of *Agrimonia L.* were identified. This included questioning students and teachers, assessing students' readiness to use websites through expert control works, generalizing and studying pedagogical experience, and performing a theoretical analysis of the study results.

The Organizational experiment. The organizational stage is the second phase of training for 3rd-year students specializing in natural sciences, specifically in the 5V011300 — Biology program. This stage involves preparing research methods to study the biological characteristics of medicinal forms of *Agrimonia L.* and

integrating these results into the educational process. The quality of the developed educational and methodological program is verified among students. The use of the didactic potential of the elective discipline "Biological Features of Medicinal Species of *Agrimonia L.*" is determined. Lectures and laboratory classes, as outlined in the elective discipline's program, provide the necessary knowledge and facilitate proper understanding and assimilation. Samples of some classes are also provided.

The Evaluation experiment. The evaluative stage involves verifying the results of the research work. This includes assessing the biodiversity of medicinal species of *Agrimonia L.*, examining the methods of conducting classes, and evaluating students' knowledge on the elective subject. The validity of the study's results is also assessed during this stage.

## Results

The purpose of the experimental study is to verify the effectiveness of the developed methodology and implementation in the educational process in the form of curriculum for the elective discipline "Biological features of medicinal species of *Agrimonia L.*" and "*Agrimonia L.* scientific and pedagogical methods of research of a medicinal plant" (ISBN 978-601-346-004-8) [32].

Institute of Natural Science of the Kazakh National Women's Teacher Training University, for students of specialty "0511300-Biology" the elective discipline "Biological features of medicinal species of *Agrimonia L.*" was studied. The purpose of the elective discipline is to form theoretical knowledge and provide a comprehensive understanding of the biological characteristics of medicinal forms of *Agrimonia L.* It aims to familiarize students with research methods and to develop their cognitive, personal, and professional skills. Additionally, it focuses on fostering research competencies through practical work with medicinal plants.

Objectives of the discipline:

- acquaintance with the types of medicinal plants and their collection, mastering the methods of harvesting raw materials;
- familiarization with the therapeutic properties of medicinal forms of *Agrimonia L.*;
- developing knowledges about the rules of use of medicinal plants for the treatment of various diseases;
- development of the knowledges about rational use of resources of medicinal plants and the development of measures to protect them.

Expected results: during the development of the discipline students should know the practical use of officially known medicinal plants and products from them; a variety of medicinal plants in general and folk medicine, their ecology, distribution, ways of study resources, research opportunities in Kazakhstan; the importance of medicinal plants in nature, human life. In addition, the methods and techniques studied in the elective discipline on the biological features of medicinal forms of *Agrimonia L.* must be applied in practice during scientific work.

In the elective course lectures on planned topics, laboratory work with subgroups on special topics are carried out. During studying of elective discipline, it is necessary to get acquainted with the specially conducted scientific-research works on the themes of native and

foreign scientists. At the laboratory classes, students of biology learn the methods of preparation of temporary preparations and structural and functional analysis of some of the studied species. The results of the research works carried out by students lead in the form of a conclusion, as well as in the form of clear anatomical drawings with schematic lines of the form of the objects made [33]. It also provides advice to students on issues arising in the student's independent work with the teacher (SIW), the independent development of the student specified in the plan, preparation of presentations and essays, work with textbooks, test assignments, work with interactive learning programs, in small groups.

The SIW includes work with literature, additional tasks, thematic essays, defended and discussed. It promotes independent search, increases creative abilities, improve speech style and ability to work in a team. During the classes the determinants of plants of Kazakhstan, flora of Kazakhstan, list of medicinal plants of Kazakhstan, computer equipment, microscope, educational and additional manuals, electronic teaching aids are used. The student conveys his knowledge of the subject through oral questions and answers. Students in the elective discipline "Biological features of medicinal species of *Agrimonia L.*" receive new knowledge about the biological features of drug forms, pharmacology. They learn to solve problems and obtain results independently and master the methods, the basics of research.

Lecture topics:

1. Medicinal plants growing in Kazakhstan.
2. General characteristics of the Rosaceae family.
3. Biologically active substances (surfactants) in the composition of medicinal plants.
4. Description of medicinal forms of the relative, areal distribution *Agrimonia L.*
5. Biological features of related medicinal forms, application in pharmacy and folk medicine *Agrimonia L.*
6. Morphological and anatomical methods of investigation of related medicinal forms *Agrimonia L.*
7. Biochemical studies of related dosage forms *Agrimonia L.*
8. Methods of molecular, genetic research of medicinal forms of related plants *Agrimonia L.*
9. Importance of medicinal plants in the biosphere and human life and their protection.

Below are the results used in the formation of research competencies of students, models of learning innovative method of individual topics in the elective discipline "Biological features of medicinal species of *Agrimonia L.*"

Theme of the lecture class: Biological features of medicinal species of *Agrimonia L.*, application in pharmacy and folk medicine. Method of the lesson: Just-in-Time Teaching (JiTT), information and communication technologies. Visibility of the lesson: laptop, Internet, website or learning management system, presentation, slides, etc. Interdisciplinary connections: computer science, ecology. The purpose of the lesson: formation of ability and ability to creative activity of the person, time saving. Developing: critical thinking, development of active teaching methods and skills, quickness, feedback.

Organizational stage: issuing tasks to the students on the preliminary topic.

## Tasks:

1. Botanical description, distribution of species *Agrimonia L.*: *A. asiatica Juz.*, *A. pilosa Ldb.*
2. Biological features of the species *A. Eupatoria L.*
3. Scientific data on medicinal species of *Agrimonia L.*
4. Biologically active substances of species *Agrimonia L.*
5. Therapeutic properties and use of species *Agrimonia L.*

In this method, to save time in the classroom, trainees are given assignments on a topic 24 hours in advance of the analysis time. Assignments are completed via the Internet, a website, or a learning management system. Trainees will prepare and demonstrate the assignment in advance in the form of a presentation, slides, etc. It is possible to review the trainees' answers in advance, expand on the topic, make changes.

During the lecture, excerpts from the students' answers to the above assignments were given. Thus, the new topic was discussed together with the students. Based on the work of students, using their prepared answers as a starting point, formed and directed to active learning creative activity and abilities of the individual. For example, 1, 3, 5 tasks were fully mastered by the students on the answers, and the analysis in the classroom was reduced. And 2, 4 were added to the audience due to the fact that it had difficulty in completing the tasks.

Conclusion: trainees were assessed and given assignments on the following topic. In the course of the elective discipline the content of the topics is disclosed and contributes to the assimilation of the learners. Below we will present a thematic plan of the laboratory lessons of the elective discipline (1st grade) and a sample laboratory lesson.

## Topics of laboratory classes:

1. Use of plant objects in laboratory classes.
2. Ways of using medicinal plants.
3. Morphological studies of medicinal species of *Agrimonia L.*
4. Arrangement and operating rules of a binocular biological microscope MCX100.
5. Preparation fixation for anatomical studies of medicinal species of *Agrimonia L.*
6. Making temporary and permanent sections for anatomical studies from organs of medicinal species of *Agrimonia L.*
7. Methods for anatomical studies of the vegetative organs. Use of the Microvisible binocular biological microscope MCX100 program in anatomical studies of the vegetative organs of medicinal species of *Agrimonia L.*
8. Determination of peroxidase enzyme activity in leaves, stems, and roots of medicinal species of *Agrimonia L.*

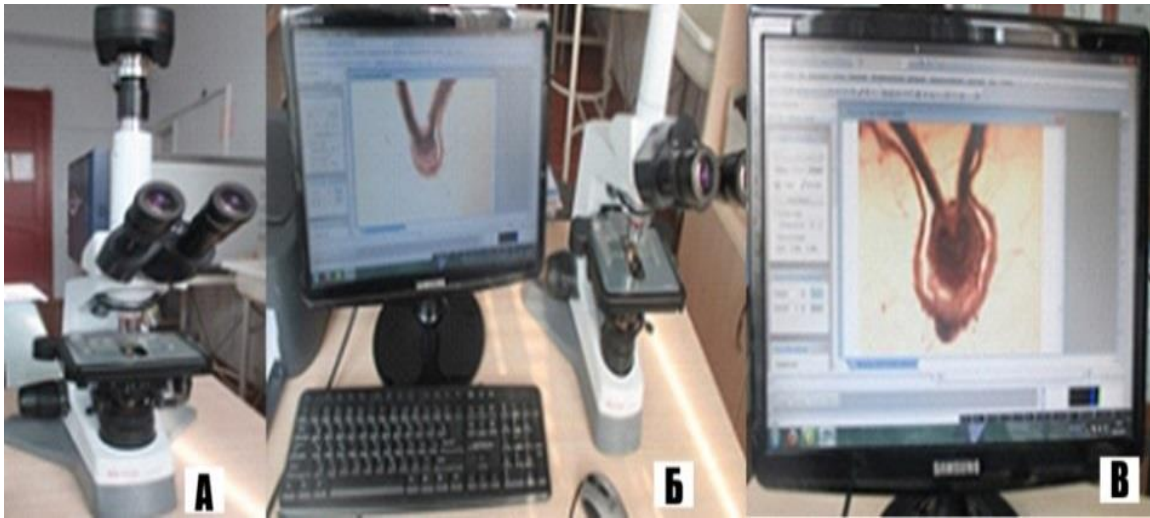
9. Determination of cytoplasmic protein in the stem of medicinal species of *Agrimonia L.*
10. Determination of esterase enzyme activity in leaves, stems, and roots of medicinal species of *Agrimonia L.*
11. Method for analysis of polymorphism of relative dosage forms and gene labeling of medicinal species of *Agrimonia L.*
12. Method of DNA isolation from leaves of drug forms of a relative of medicinal species of *Agrimonia L.*
13. Isolation of GAPDH (glyceraldehyde-3 phosphate dehydrogenase) gene from plant of medicinal species of *Agrimonia L.*

Sample laboratory lesson is described below.

Topic of the laboratory lesson: Using the Microvisible binocular biological microscope MCX100 program in anatomical studies of vegetative organs of medicinal species of *Agrimonia L.* Method of the lesson: information and communication technologies, group work. Visualization of the lesson: computer, interactive whiteboard, MCX100 microscope, preparations made from vegetative organs of medicinal species of *Agrimonia L.* Purpose of the lesson: mastering of additional possibilities with the use of innovative equipment, increasing of quality, development of laboratory works and increasing of students' interest to the science.

Objects and methods of research: binocular biological microscope MCX100 Micros with Microvisible software (Austria). The study was conducted in *Agrimonia asiatica Juz.*, growing in the Talgar Mountains, at an altitude of 1600 m above sea level. Samples of the plant were taken. Plant specimens were fixed according to Strasburger-Flemming, anatomical structure of which was carried out according to M.N. Prozina's methodology. Temporary preparations were prepared for anatomical studies according to generally accepted methods of structural analyses. Anatomical cuttings of the leaf, stem, and root of the plant were made using an electronic microtome MZP-01 "Tekhnom" (Ekaterinburg), anatomical cuttings were 10-15  $\mu\text{m}$  thick.

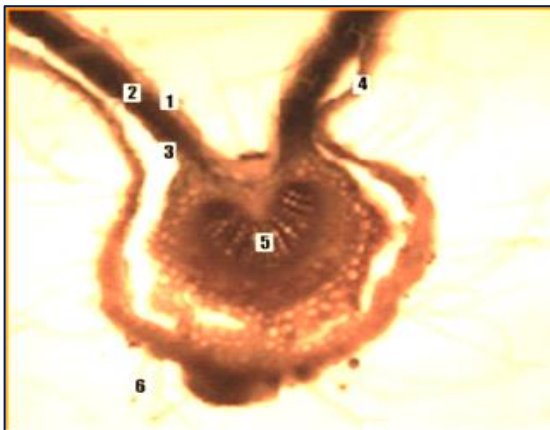
The study of the anatomical structure of the leaf and rhizome of the medicinal plant under a binocular biological microscope MCX100 (Figure 1) was carried out. *Agrimonia asiatica Juz.* with special program Microvisible, connected to a computer. Horizontal slices of above-ground and underground parts of medicinal plant were plotted on micrometers and morphometric measurements were carried out. Ideal for work with a microscope, the use of Microvisible software significantly increases the quality and quantity of readings. Results of the study and conclusions: when working with a microscope, the image of the micropreparation is immediately displayed on the computer screen.



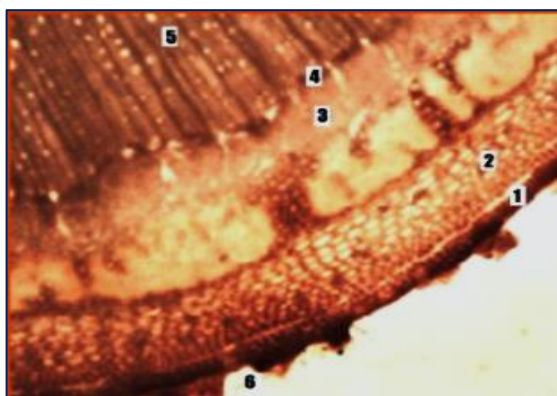
**Figure 1.** Microscope MCX100. A-Binocular MCX100 biological microscope in working condition, Б – working condition with Microvisible software, B – *A. asiatica Juz* on the computer screen horizontal slice of a plant leaf

Morphometric measurements, micrometric imaging, and its storage are performed using the Microvisible program.

*A. asiatica Juz.* micrometers of leaf and rhizome transverse sections of the plant taken with the Microvisible program using an MCX100 binocular biological microscope are shown in Figures 2-3.



**Figure 2.** *A. asiatica Juz.* anatomical structure of the leaves of the plant: 1 – the upper epidermis, 2 – columnar mesophyll, 3 – loose mesophyll, 4 – lower epidermis, 5 – conductive bundle, 6 – fibers



**Figure 3.** *A. asiatica Juz.* anatomical structure of the plant rhizome: 1 – periderm, 2 – sclerenchyma, 3 – floem, 4 – cambium, 5 – xylem

Expected results: in the laboratory lesson students should master the construction and use of new technical means in the educational process; increasing the quality of knowledge, formation of research competence of students through the use of technical means at the lessons and the use of these means

Conclusion: the use of computer programs in the learning process to train future specialists in biology is considered effective. In the process of training in pedagogical universities at a high level is carried out to improve the quality of experimental work on the formation of research competencies of future specialists-biologists, introduction to science, the use of new innovative technologies. This helps trainees to act independently.

Today, *Agrimonia asiatica Juz.* is used as a pharmacological raw material in Kazakhstan, valued for its potent flavonoids and tannins [34].

Numerical quality indicators were determined: (moisture; total ash; ash insoluble in 10% hydrochloric acid solution; crushing of raw materials;) the plant *Agrimonia asiatica Juz.* as well as the content of extractive substances (Table 1). The obtained numerical indicators allow us to establish the quality of medicinal plant raw materials and will be used to obtain extractive preparations on the basis of Asian burdock (*A.asiatica Juz.*).

**Table 1.** Determination of numerical indicators of quality in leaves of Asian burdock (*A. asiatica Juz.*)

No.	Numerical quality indicators	Mean, %
1	Humidity	8.255
2	Total ash	9.287
3	Ashes insoluble in 10% hydrochloric acid solution	0.764
4	Extractive substances 50% ethyl alcohol solution	27.4

From the data in the Table 1, it follows that the raw material Asian burdock (*A. asiatica Juz.*) are of proper quality. Numerical indexes are within the limits of admissible values presented to LRS. The studied plant Asian burdock (*A.asiatica Juz.*) corresponds to the

recommended requirements on numerical indicators and is used for definition of BAS and for studying and definition of acute toxicity and specific activity of extracts of burdock asiatica. Application of the received data will rationally allow to increase efficiency of technological process at manufacture of extractive preparations.

In the teaching aid prepared in the course of the study, the methods of morphological, anatomical, biochemical and genetic study of vegetative organs of related drug forms are shown. In addition, a brief description of some pedagogical innovative methods used in the training of biologists is given. Mastering the methods of research is necessary for future teachers both in the educational process and in practical activities. The manual is designed for future pedagogical students, undergraduates, doctoral students and specialists in this field.

When using the research project in the educational process there is an interest of students in scientific research, development of ideas about biological concepts based on laboratory research. The work on the research project planned for 4 or 7 weeks on a particular topic is created and conducted. At the end of the project, students learn various laboratory methods and gain a thorough understanding of the topic [35; 36]. The discussion method not only proves or disproves assumptions, but also teaches the student to choose positive arguments in defense of his/her point of view, to listen and hear his/her interlocutor. The main functional qualities of personality are activity, the ability to think creatively, make decisions and choose a professional path, constant readiness to gain knowledge [37; 38]. According to the new concept of higher education development, the priority tasks of higher education institutions are not only qualification improvement and formation of skills of future specialists, but also development of their abilities to self-education, preparation for independent actions and decision making, upbringing of responsible attitude to themselves, their work and actions [39; 40].

## Discussion

In higher education, teachers experimentally shape students' biological knowledge and skills, aiming to uncover the effective utilization of methods and techniques employed in studying the biological characteristics of medicinal species such as *Agrimonia L.*. In the course of the ascertaining experiment the level of biological knowledge of students was revealed through a specially prepared questionnaire on the content, motivational and activity components. Training in the experimental group on the basis of the educational and methodological program prepared for the elective discipline "Biological features of medicinal species of *Agrimonia L.*". Training in the control group was held in the form of a traditional lecture, laboratory class. The results of the pedagogical experiment were summarized and methodical recommendations were given. The used literature was systematized. Experimental work was prepared on demand.

The results of the survey of students of Natural Science Institute of Kazakh National Women's Teacher Training University showed that 12% of the respondents are ready to give knowledge about medicinal plants, 38% are not prepared enough, and 50%, realizing the need for medicinal plants, do not actively respond to the issue. To ensure the experimental and pedagogical work related to the possibilities of the educational process of the university, the need for the formation of biological knowledge and perceptions related to the problem under study was identified. During the ascertaining experiment it was found that students in general know information about medicinal plants, and knowledge about individual species is insufficient. They showed a low level on the activity indicator, with difficulties noted in the activity and decision-making in the work with the group.

In order to determine the formed level of biological knowledge, skills and abilities of students, questionnaires, question-answers were used. The results of the ascertaining, forming and control experiments in the course of the study allowed to determine the indicators and criteria of students' knowledge and their levels (high, medium and low) (Table 2).

**Table 2.** Characteristics of the level of biological knowledge of students about medicinal plants

Levels	Motivational	Informative	Activity
Low	Biological knowledge on the level of knowledge of the definition of general biological terms and concepts	Is not aware of his/her actions, responsibility in protection of medicinal plants	In works to protect medicinal plants
Medium	Biological knowledge understanding of the importance of medicinal plants in human life at the level of interest	Treats nature as a value	No clear position in actions to protect medicinal plants
Higher	Biological education well formed as a person	Possesses data about medicinal plants, understands their necessity well, has a clear, sustained trust	While studying medicinal plants, freely uses learned methods and techniques in the course of classes. Has a specific goal, makes decisions

Indicators of levels of development of components of formation of students' biological knowledge of medicinal plants at the beginning and end of the experiment (Table 3).

**Table 3.** Indicator of the level of formation of biological knowledge of students about medicinal plants (%), (EG – 54; CG – 45)

Component s	Work Stages	High		Medium		Low	
		E G	C G	E G	C G	E G	C G
Motivational	Beginnin g	28	27	35	35	37	38
	End	35	27	49	36	16	37
Content	Beginnin g	25	24	36	37	39	39
	End	37	25	48	37	15	38
Activity	Beginnin g	27	26	33	34	40	40
	End	36	25	47	35	17	40

**Note:** EG – experimental group; CG – control group.

Levels of motivational component of biological knowledge about medicinal plants were determined by a pre-prepared questionnaire. From the results of the study, we can see that if in the experimental group initially there were 37% of students who showed a low level, at the end of the experiment the number of students who showed a low level decreased by 16%, in the average by 35%, at the end they were 49%, at the beginning a high level was shown by 28% of students, at the end their number increased by 35%. And in the control group no significant changes were observed.

The levels of the content component of students' biological knowledge of medicinal plants in the experimental group according to the survey initially showed a low level – 39%, at the end of the experiment showed a low level – 15%, in the average – 36%, at the end – 48%, in the beginning a high level showed 25% of students, at the end – 37%. And in the control group there was no change. The number of students who showed a low level on the levels of the activity component determined by the survey was 40%, at the end of the experiment the number of students who showed a low level decreased by 17%, at the end of the average – 33%, at the end – 47%, at the beginning of the high level – 27%, at the end – 36%. No changes were observed in the control group.

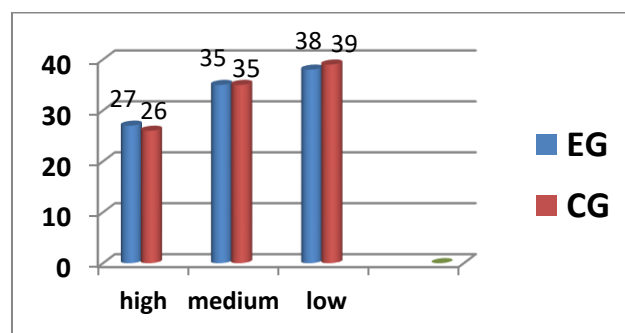
Changes in the level of formation of students' biological knowledge about medicinal plants in the course of experimental work are presented in the table below (Table 4).

**Table 4.** Level of structural components of students' biological education at the end of the experiment, (in number of students) (ET-54; BT-45)

Structural Components	Low level		Medium level		High level	
	CG	EG	CG	EG	CG	EG
Motivational	17	8	16	27	12	19
Informative	17	8	16	26	11	20
Activity	18	9	15	26	11	19

From the analysis of the results of questioning, tests, control and laboratory work conducted in the control and experimental groups, due to the data presented in the table above, it is clear that the average level of biological

knowledge in the experimental group is higher, and a positive result is noted. Experimental indicators of students are given in the form of a comparative diagram (Figure 4), based on criteria based on high, low, average levels. The general indicators of motivational, content, activity components of biological knowledge of students on the basis of medicinal plants at the beginning of the experiment at the ascertaining stage were determined and are shown in the diagram in Figure 4. As can be seen from the diagram, we see that the indicators of EG and BT at the beginning of the experiment are comparable with each other by high, medium and low criteria.



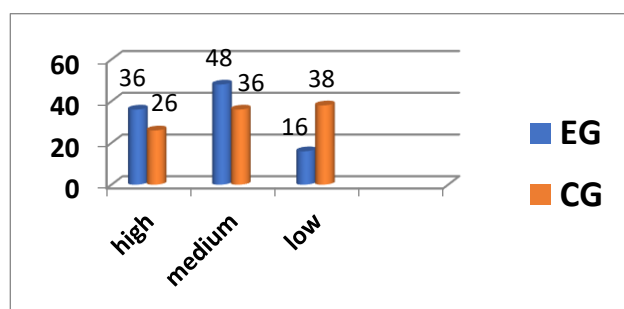
**Figure 4.** Diagram of the level of biological knowledge of students based on the use of research results in the learning process (at the beginning of the experiment, %)

To deepen the notions of future biology specialists about medicinal plants, revealing their opportunities for comprehensive learning during the formative experiment and to fulfill the tasks that emerged during the implementation of this goal, the experimental work was carried out in three stages. Works at the initial stage of the formative experiment are designed to assimilate the students of the subject of activity “Methods of scientific and pedagogical research of medicinal plant *Agrimonia L.* The textbook introduces future professionals to the biological features of medicinal plants and teaches their analysis, how to make preparations, the order of the experiments, how to conduct them in the laboratory. The methods used in the study of the biological features of medicinal plants are also given. Mastering the methods of research is necessary for students not only in the learning process, but also in their subsequent practical activities.

At the second stage of the formative experiment during the execution of the laboratory classes specified in the program of the elective course, works were organized and knowledge was supplemented. In the course of the laboratory class students supplement their theoretical knowledge by performing the specified works, tasks from a practical point of view. In diagnosing the formation of knowledge of future specialists-biologists about medicinal plants in the lecture class were used lecture – just-in-Time Teaching (JiTT), ICT, in the laboratory class – ICT, group work, paired method, as well as observation, conversation, questioning, experimental evaluation, etc.

At the end of the experimental experiment, we found common indicators of motivational, content, activity components of biological knowledge of students on the basis of medicinal plants. From the diagram shown in Figure 5, we can see that when removed from the indicators of the beginning of the experiment, high and

average levels of EG significantly increased, and the low level decreased. No significant changes were observed in BT indices.



**Figure 5.** Diagram of the level of biological knowledge of students based on the use of research results in the learning process (at the end of the experiment, %)

Thus, comparing the indicators in the ascertaining, forming and control experiments of the study, we can state that the high level of biological knowledge demonstrated 36% of students, the average – 48% and low – 16%.

Conducted work on the methodology developed during the study contributed to the replenishment and formation of biological knowledge of students, summarizing the practice. According to the results of the forming experiment there is an excess of indicators over the conclusions. During the control experiment based on the biological characteristics of medicinal plants, we observed positive results of the works conducted and the results of the surveys. In the course of the ascertaining experiment and in comparison, with the indicators of the control group, the results of the surveys showed a significant increase. If the systematically conducted experimental work showed the effectiveness of the proposed scientific methodology,

the learning process has certainly achieved a positive result [41-45].

## Conclusions

The developed program of the elective discipline and the educational-methodical manual “Biological features of medicinal species of *Agrimonia L.*” and “Methods of scientific and pedagogical research of medicinal plant *Agrimonia L.*” (ISBN 978-601-346-004-8) allows to develop forms and methods of biological education during training of biology specialists and to organize independent activity of students in the educational process. The method characterizes mastering by students of biology and ecology the studying of medicinal plants by innovative methods, and the formation of research competence.

The technique provides a high level of biological knowledge of experts-biologists, contributes to the study of methods of research of medicinal plants, the possibility of research work in Kazakhstan; knowledge of the important place of the medicinal plant in nature, human life, its protection. Experimental work carried out during the study proves the effectiveness of the methodology of biological education in the training of specialists in biology.

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## Conflict of Interest

The authors declare that they have no conflicts of interest.

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## **Технологія формування дослідницької компетентності майбутніх біологів: на прикладі вивчення роду *Agrimonia L.***

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### **Анотація**

**Актуальність.** Однією із сучасних вимог парадигми розвитку сучасної освіти є підтримка дослідницької роботи студентів та їхнього інтересу до науки. Вивчення біологічних особливостей лікарських рослин формує їх як професіоналів і розвиває дослідницьку компетентність.

**Мета.** Метою дослідження є розвиток когнітивних, особистих і професійних навичок студентів, культивування їхніх дослідницьких компетенцій через вивчення лікарських рослин.

**Методологія.** В експериментальному дослідженні, проведеному в Казахському національному жіночому педагогічному університеті, взяли участь 99 студентів третього курсу спеціальності “Біологія” (0511300-Біологія). З них 54 студенти становили експериментальну групу, а 45 студентів – контрольну.

**Результати.** У межах даного дослідження розроблено та випробувано програму факультативної дисципліни “Біологічні особливості лікарських видів *Agrimonia L.*” І навчально-методичний посібник та розроблено навчальні моделі інноваційних методик. Під час експерименту було проведено анкетування для оцінки біологічних знань учнів за змістовим, мотиваційним та діяльнісним компонентами. Результати педагогічного експерименту закріплено і супроводжено методичними рекомендаціями.

**Висновки.** Було визначено, що розроблена програма та посібник “Біологічні особливості лікарських видів *Agrimonia L.*” покращує освіту студентів-біологів, сприяючи самостійному навчанню. Вони зміцнюють досвід серед біологів, зокрема у дослідженні лікарських рослин, сприяючи усвідомленню їх екологічної значущості та сприяючи зусиллям щодо їх збереження. Експериментальна перевірка підтверджує ефективність такого навчального підходу для біологів.

**Ключові слова:** *Agrimonia L.*; навчальний план; методологія; дослідження; компетентність; вивчення лікарських рослин.