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FORMATION OF RESEARCH COMPETENCIES OF FUTURE BIOLOGY TEACHERS THROUGH FIELD TRAINING PRACTICE

Abstract

Today, much attention is paid to school education and improving the education system as a whole. One of the key competencies is research competencies that are formed in the process of undergoing field training and laboratory work, preparing scientific publications and reports for seminars, conferences and symposia. Also, research competencies are an indicator of the competitiveness of future biology teachers and a guarantee that the teacher will be able to engage not only in teaching the subject but also engage in design and research work with students, pedagogical research and make scientific publications to improve their level of qualifications. The purpose of this work is to study the formation of research competencies of future biology teachers through educational and field practice of second-year students in invertebrate zoology during the summer. The scientific significance of this work is the study of methods and forms used during summer field training by students majoring in biology and evaluation of the effectiveness of these methods. The work is valuable for methodologists at higher educational institutions, students, undergraduates and doctoral students studying methods of teaching biology, the formation of research competencies and education in general. The results of this work were used in the preparation of work curricula for field training for biology students and the selection of forms and methods for conducting field training.

Keywords: Research competence, field practice, scientific work, qualifications, university, biology.

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ФОРМИРОВАНИЕ ИССЛЕДОВАТЕЛЬСКИХ КОМПЕТЕНЦИЙ БУДУЩИХ УЧИТЕЛЕЙ БИОЛОГИИ ПОСРЕДСТВОМ УЧЕБНО-ПОЛЕВОЙ ПРАКТИКИ

Аннотация

Сегодня много внимания уделяется школьному образованию и улучшению системы образования в целом. Одной из ключевых компетенций является исследовательские компетенции, которые создаются в процессе прохождения полевой подготовки и лабораторной работы, подготовки научных публикаций и отчетов о семинарах, конференциях и симпозий. Кроме того, исследовательские компетенции являются показателем конкурентоспособности будущих учителей биологии и гарантии того, что учитель сможет участвовать не только в преподавании предмета, но и участвовать в проектировании и исследовательской работе со студентами, педагогические исследования и создавать научные публикации для улучшения их уровень квалификации. Целью этой работы является изучение формирования компетенций исследований будущих преподавателей биологии посредством образовательной и полевой практики второго курса студентов в зоологии беспозвоночных летом. Научной значимостью этой работы является изучение методов и форм, используемых во время летнего полевого обучения студентами, занимающимися биологией и оценкой эффективности этих методов. Работа полезна для методистов в высших учебных заведениях, студентам, магистарнтам и докторантам, изучающих методы преподавания биологии, формирование исследовательских компетенций и образования в целом. Результаты этой работы использовались при подготовке учебных программ для работы со студентами и выборе форм и методов для проведения учебно-полевогых практик.

Ключевые слова: исследовательская компетентность, полевая практика, научная работа, квалификация, вуз, биология.

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ОҚУ-ДАЛАЛЫҚ ПРАКТИКА АРҚЫЛЫ БОЛАШАҚ БИОЛОГИЯ МҰҒАЛІМДЕРІНІҢ ЗЕРТТЕУ ҚҰЗЫРЕТТІЛІКТЕРІН ҚАЛЫПТАСТЫРУ

Аңдатпа

Бүгінде мектептегі білім беруге және жалпы білім беру жүйесін жетілдіруге көп көңіл бөлінеді. Негізгі құзыреттердің бірі - ғылыми-зерттеу құзыреттілігі, бұл далалық іс-тәжірибеге дайындық және зертханалық жұмыстар, ғылыми жарияланымдар мен семинарларға, конференцияларға және симпозицияларға арналған ғылыми жарияланымдар мен есептерді дайындау процесінде қалыптасады. Сондай-ақ, ғылыми құзыреттілік болашақ биология мұғалімдерінің бәсекеге қабілеттілігінің көрсеткіші болып табылады және мұғалімнің тек пән бойынша оқытуда ғана емес, сонымен қатар педагогикалық зерттеулермен және ғылыми жарияланымдармен айналысуға және ғылыми-зерттеу жұмыстарына қатыса алатындығына кепілдік беретін олардың біліктілік деңгейі. Бұл жұмыстың мақсаты - жазғы омыртқасыз зоология пәнінен өтетін далалық іс-тәжірибеде екінші курс студенттерінің зерттеушілік құзыреттілігін қалыптастыру. Жұмыстың ғылыми маңыздылығы - биолог студенттердің зерттеушілік құзыреттілігін дамытып және осы әдістердің тиімділігін бағалау кезінде қолданылатын әдістер мен формаларды зерттеу. Жұмыс жоғары оқу орындарында, студенттерге, магистранттарға және докоранттарға, биологияны оқытудың әдістері, ғылыми құзыреттіліктерді қалыптастыру және жалпы білім беру әдістері үшін құнды. Бұл жұмыстың нәтижелері биология студенттеріне

далалық іс-тәжірибелерге дайындық үшін және жұмыс оқу жоспарларын дайындауда іс-тәжірибелердің формалары мен әдістерін таңдауда қолданылды.

Түйін сөздер: зерттеу құзыреттілігі, далалық тәжірибе, ғылыми жұмыс, біліктілік, ЖОО, биология.

Basic provisions. The article focuses on the importance of building and enhancing research skills among biology teachers. It emphasizes that teachers should not just impart knowledge but also cultivate their students' ability to conduct research. This involves various tasks such as laboratory work, field practice, data analysis, and student participation in research. While practical exercises and field research play a crucial role in developing research competence, the article suggests that innovative methods should be incorporated to improve the effectiveness of this process. The article recommends the formulation of new methodological approaches to enhance research competence through field practice.

Introduction. New approaches and strategies for changing and modernizing secondary education directly affect the skills of educational personnel. Consequently, new requirements are being imposed on graduates of higher educational institutions, for example, future teachers must not only know their subject and teaching methods, developmental psychology and general pedagogy, but must also possess competencies that are formed in the learning process. Research competence plays an important role in both faculty careers and student achievement, especially in biology. Thanks to the formation of research competencies, students also develop critical thinking. It allows them to analyze and evaluate information, formulate hypotheses, conduct experiments and draw conclusions based on the data obtained, which contributes to an in-depth understanding of the subject as a whole [1]. Consequently, developed research competencies allow for a deeper and more accurate understanding of biological concepts and processes. Helps teachers deepen their knowledge and students better understand educational material. It has been noted that research competence stimulates teachers and students to develop new methods and approaches in the field of biology [2]. They can conduct their own research, apply new technologies and find innovative solutions to scientific problems. Another point in favor of research competence is that teachers with research competence can develop interesting and effective teaching materials and techniques that encourage students to actively engage with the subject matter and stimulate their research skills. Also, the research competence of biology teachers makes them more competitive in the labor market. The ability to conduct scientific research and have real achievements in this field increases the chances of getting a highly paid and prestigious job [3]. Therefore, research competence plays an important role in faculty careers and student success in biology. It promotes the development of critical thinking, in-depth understanding of the subject, innovation, improvement of the learning process and increased competitiveness. Among many forms, methods and academic disciplines, it is field training that contributes to the development of research competencies [4]. When conducting a survey among biology teachers and students, the majority responded that it was educational field practices that helped to develop research competencies (Fig. 1).

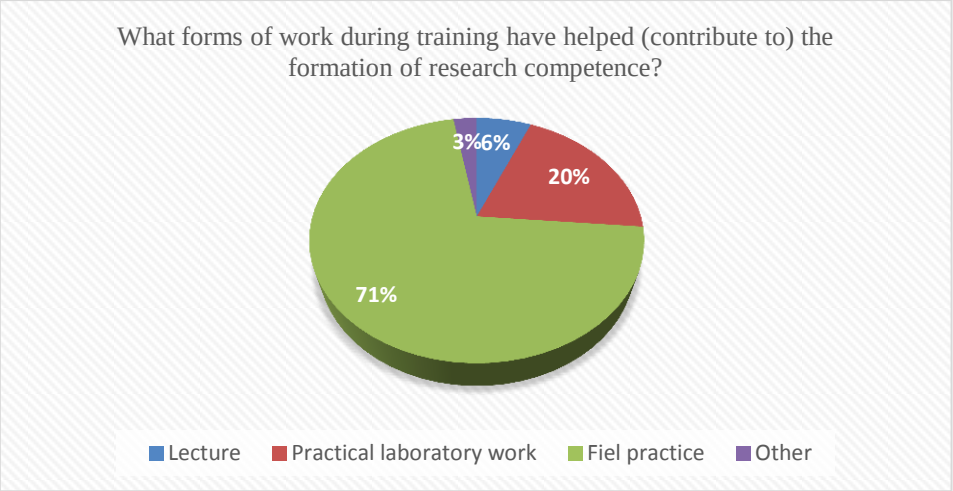

Figure 1. Results of a survey among teachers and students (A. Abdildauly, 04.10.2023)

Summer educational field practice in invertebrate zoology is a mandatory component of the educational program for students.

Purpose of practice:

1) obtaining, deepening and consolidating knowledge of the local fauna vertebrates;

2) mastering techniques for collecting field material and working with field equipment;

3) training in skills of working with identifiers;

4) gaining first experience in conducting simple independent research on a chosen topic.

Field practice in invertebrate zoology includes mastering methods for collecting material, directly collecting field material, which is fixed in formaldehyde, alcohol or mounted in the form of a collection, its independent determination, compiling a list of discovered species, sketches of the appearance of discovered invertebrate animals, conducting independent field research .

The main objectives of educational zoological practice:

- mastering methods of collection, laboratory processing (identification, fixation, herbarization, labeling) and storage of collection materials of organisms of various systematic groups;
- identification of ecological characteristics of invertebrate animals within certain ecosystems;
- obtaining the necessary skills for independent conduct of educational and research work in the field;
- determination of the role of living organisms identified in practice in nature and human economic activity.

As a result of studying the discipline, the student must:

know:

- taxonomic and syntaxonomic diversity of local fauna, features of ecological groups;
- systematic position, scientific names, features of biology and ecology of the studied objects;
- methods for diagnosing living organisms of different systematic groups;
- basic methods and particular techniques of scientific research work on studying the structure of fauna and flora, establishing biocenotic connections of invertebrate and vertebrate animals, algae, lichens, higher plants and their role in the functioning of ecosystems;

be able to:

- identify representatives of regional fauna;
- correctly prepare and arrange zoological collections and maintain scientific documentation;
- use basic methods and private techniques when conducting field research;

- organize and conduct excursions in nature.

Material and methods. Collection of soil invertebrates. Classic collection methods are standard soil samples for mesofauna (Gilyarov, 1975a) and Barber traps (Tikhomirova, 1975). The first method is designed to identify the number of soil invertebrates per 1 m2, for this purpose on areas measuring 50 cm × 50 cm in in field conditions, layer-by-layer analysis of the soil is carried out using special oilcloths. As a rule, animals are found in the first layer soil depth from 0 cm to 10 cm and the second - from 10 cm to 20 cm. These objects are placed in bags made of thick fabric (earthworms) and vesicles (other invertebrates). If bedding is available (forest biotopes), then it is collected in medium-sized bags made of tissue and then examined in laboratory conditions using We eat a set of soil-zoological sieves. In each biotope it is taken 4 or 8 samples each. Samples are supplied with labels.

The second method is Barber traps, which can be used as glass half-liter jars or plastic cups with a diameter of 8 cm, which are made from 1.5 liter bottles. Traps are dug level with the soil surface. In each biotope, 10 trapping jars are installed in a line every ten meters. A fixing liquid is poured into the bottom of the trap, which is a 20% solution of table salt or formalin. If for one reason or another there is no retainer, then a little soil should be poured onto the bottom of the trap so that the objects caught there can hide from each other, and thereby reduce the possibility of small insects being eaten by large predators. Traps are set for 3–5 days, i.e., 30–50 trap days are processed per count. The contents of the jars are carefully poured into bags made of thick fabric and delivered to the laboratory, where they are then carefully disassembled. Each sample is supplied with a label. In the future, Barber traps make it possible to calculate the catchability (dynamic density) of soil invertebrates. Catchability is calculated using the formula: $U = k / (n – h) t$, where U is catchability, k is the total number of all individuals of the species in all samples, n – number of traps, h – number of failed traps, t is the time for which the traps were installed.

After calculation, the obtained catchability indicators in various biotops are standardized per 100 trap-days for comparison. To collect myrmecophilous insects, jars are installed near anthills or on ant trails.

To collect small arthropods (ticks, springtails) use special installation - eclector. Its action is based on the high sensitivity to drying characteristic of all small soil invertebrates. A lump of soil is placed on the grid under the lamp. When it dries, the microarthropods rush down and fall onto the mesh, and then fall into a funnel connected to a test tube containing a fixing liquid.

Collection of terrestrial invertebrates. The classic technique is collection using an entomological net, which has a device similar to that of a hydrobiological net (see Fig. 3). However, unlike a hydrobiological net, it is better to make a net from a more delicate fabric, for example from mill gas. To count the number of invertebrates in the herbaceous layer, two methods are used. The simplest is mowing the grass with a standard size entomological net (a hoop with a diameter of 30 cm, a bag depth of 60–70 cm and a handle length of 1–1.5 m). The collector walks evenly so that with each stroke the net covers a certain distance. After each swing, one step is taken. Counting is carried out for 50 or 100 strokes. The contents are then quickly shaken out into the wide-mouth stain. Each sample is supplied with a label. In order to calculate the number per unit area, you can use the formula of L. G. Dinesman (according to Brodsky et al., 1983): $X = N / 2 RL n$, where X is the number of insects per 1 m^2, N – number of insects caught during mowing, R – net radius in meters,

L – average length of the path traversed by the hoop of the net along the grass stand with every swing, n – number of swings (blows) of the net.

However, the obtained figures are not absolute. To more accurately account for the number of invertebrates in the herbaceous layer, a biocenometer is used. Using it, an area of soil and grass measuring 50 cm x 50 cm is isolated. Then a complete sampling is carried out. 4 or 8 samples are taken from each biotope. Each sample is supplied with a label.

To count nocturnal insects (lepidoptera, coleoptera, lacewings), light traps are used. To collect nocturnal lepidoptera, a white fabric screen is used, onto which light is directed. The illuminated screen attracts insects and they land on it. It is better to spread oilcloth, plastic film or white cloth under the screen to make it easier to collect insects that have fallen from it.

The second type of light trap is designed to collect small nocturnal insects. It consists of a lamp, under which there is a funnel connected to a vial filled with a fixing liquid. Insects attracted by the light hit the lamp and fall into the funnel. Such a trap is installed overnight, and in the morning the material is analyzed in a laboratory setting.

During summer practice, manual picking is widely used. Manure and compost heaps, mushrooms, rotting plant remains, corpses of vertebrate animals, rotten stumps and wood, banks of rivers and lakes, substrate under stones, snags and moss are manually inspected. For manual collection, tweezers, exhausters and scoops are widely used. The exhauster is used to collect small objects. It is made of a glass cylinder with two tubes inserted into the lid. One tube has a long rubber hose on the outside and a mill gas cap on the inside. The other end of the hose is brought to the mouth or a rubber bulb is put on it. By simultaneously holding the end of the glass tube towards the small insect and drawing in air through the hose, you suck the object into the cylinder.

Storage of collected material.

The collected material is recorded and stored depending on its specifics. Aquatic invertebrates (except mollusks) and worms are fixed in a 4% formalin solution or in a 70% ethyl alcohol solution. It is preferable to fix large aquatic insect larvae in a 4% formaldehyde solution. Mollusks, both aquatic and terrestrial, are fixed only in a 70% (no less) solution of ethyl alcohol, since formaldehyde destroys calcareous shells. To obtain collectible mollusk shells, the maceration method is used, i.e. natural decomposition of the soft tissues of the mollusk. Spiders, insect larvae and some adult insects are fixed in a 70% ethyl alcohol solution. It must be remembered that the volume of the fixative must be at least 2/3 of the volume of the object. The fixed material is stored in glass or plastic, but always hermetically sealed containers.

After fixation, all insect adults are pinned onto entomological pins. Lepidoptera, Hymenoptera, Reticuloptera and some others are euthanized in stain and then pinned.

Chloroform is used for stains.

(!) Formaldehyde and chloroform are toxic substances! Working with them requires increased caution - it is undesirable to even get them on the skin! If the above substances come into contact with your skin, you must immediately wash the area where the fixative comes into contact with running water and soap!

It is necessary to pin insects on entomological pins according to generally accepted standards. The right side of the body is pierced in most insects, except butterflies, hymenoptera and some others. The insect is pinned with 2/3 pins at an angle of 90° relative to the body. The method of spreading lepidopteran insects is quite complex. After being euthanized in the stain, the butterflies are placed in entomological envelopes in the field and in this form are delivered to the laboratory. Then, in laboratory conditions, the wings of butterflies are spread on a special spread according to a certain standard.

First, the butterfly is pinned into the straightening groove so that the abdomen is completely in the groove. A small piece of cotton wool is placed under the abdomen. Next, using a dissecting needle, the wings are raised and secured to the straightening using thin strips of paper and pins, and then

completely pressed with wide strips of transparent paper or polyethylene. The angle between the lower edge of the upper wing and the abdomen should be 90°. In order for the collections to have scientific and practical value, they must be provided with a label. The label is made of thick paper or matte tracing paper. Inscriptions on the label should be made with a sharp pencil or pen and ink.

The following information must be displayed on the label:
– Name of the animal
– Date and time of capture
– Place of capture (so that it can be found on the map)
– Where exactly the object was encountered (stone, snag, silt, etc.)
– Full name collector
The label is placed in a jar with fixed material or glued on the outside with tape.

Dried insects are provided with two labels. On first The place and time of collection, and the name of the collector are written down. On the second Latin name of the species, date and surname of the determiner. Next, the insects are stored in entomological boxes [5].

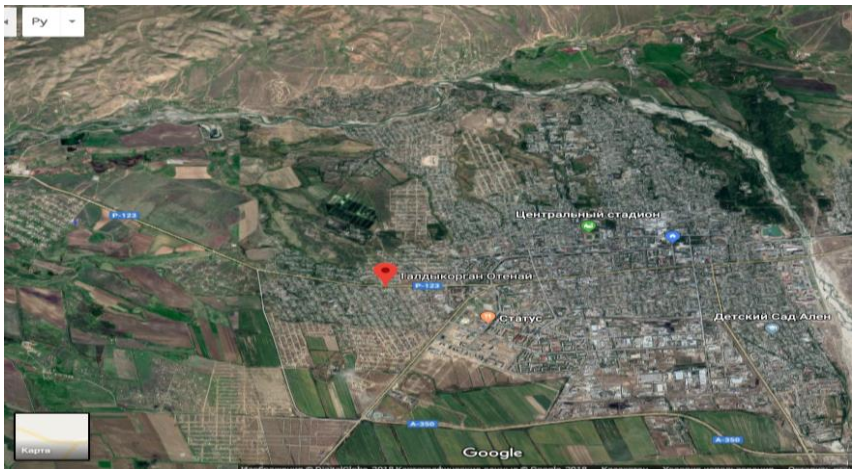

Figure 2. Location of points of collection insects

Physiographic characteristics of the internship area

Taldykorgan – city, center Almaty region Kazakhstan.

Centrally located Semirechyeon the banks Karatal Riverin the foothills Dzhungar Alatauat an altitude of over 602 m above sea level.

City climatecontinental. The average temperature in January is −11–13°C, in July 22–24°C. Average annual quantityprecipitation350-400 mm, most of them occur in the periods March-May and November-December. In wind rose northeastern (34%) and northern (16%) winds predominate. Stablesnow coverforms in the last ten days of November and ends in the second ten days of March.

Sample collection was carried out in the residential area of Krasny Kamen, at 2 points (Figure 2):

1. The middle mouth of the Karatal River, in a meadow near the shore. Coordinates 45.050875, 78.336910

2. Meadow next to the stream on Podgornaya street, Krasny Kamen Coordinates 45.050459, 78.329391

Results and Discussion. During the work carried out with students, over 100 samples of invertebrates were caught, the species composition was analyzed and a taxonomic list of insects was made (Table 1).

Taxonomic list of specific animals

Animal Kingdom. *Regnum Zoa*
Subkingdom *Metazoa*
Supersection *Eumetozoa*
Section *Bilateria*

Subsection Secondocavity *Coelomata*
Phylum *Arthropoda*
Class *Insecta*
Order *Lepidoptera*
Superfamily *Papilionoidea*
Nymphalidae family *Nymphalidae*
Genus *Polygonia*
Polygonia c-album
Family *Pieridae*
Pieris brassicae
Hawthorn *Aporea crataegi*
Nymphalidae family *Nymphalidae*
Peacock Eye *Inachis io*
Order *Araneae*
Family *Thomisidae*
Flower spider *Misumena vatia*
Order *Plecoptera*
Yellow-footed stonefly *Nemoura cinerea*
Dragonfly order *Odonata*
Suborder *Zygoptera*
Family Beauty *Colopterygidae*
Beauty Shiny *Colopteryx splendens*
Order *Orthoptera*
Family *Tettigidae*
Warbler *Tettigonia cantans*
Order *Hymenoptera*
Suborder *Apocrita*
Family *Specidae*
Shorthorn *Ammophila sabulosa*
Family *Formicidae*
Garden ant or black ant *Lasius niger*
Suborder *Apocrita*
Vespidae superfamily *Vespidae*
Vespidae family *Vespidae*
Medium wasp *Dolichovespula media*
Scolia family *Scolidae*
Scolia giant *Scolia maculata*
Family *Pompilidae*
Red-bellied road wasp *Anoplius viaticus*
Family *Climbicidae*
Birch sawfly *Climbex femorata*
Family *Diprionidae*
Pine sawfly *Diprion pini*
Burrowing wasp family *Sphecida*
Bee wolf *Philianthus triangulum*
Superfamily *Apoidea*
Bee family *Apidae*
Hairy bee *Dosypoda plumpis*
Leafcutter bee *Megachile centuncularis*
House bee *Apis melifera*

House bee (drone) *Apis melifera*
Carpenter bee *Xylocopa valga*
Garden bumblebee *Bombus hortorum*
Order *Coleoptera*
Family *Scarabaeidae*
Meadow beetle *Anomala dubia*
Marbled bronze *Potosia lugubris* [6]

Table 1. Frequency of occurrence and number of samples

№	Species name	Frequency of occurrence (2 – often, 1 – average, 0 – little)	Number of samples collected
1	*Polygonia c-album*	1	3
2	*Pieris brassicae*	1	4
3	*Aporea crataegi*	2	9
4	*Eye Inachis io*	0	2
5	*Misumena vatia*	2	3
6	*Nemoura cinerea*	1	4
7	*Colopteryx splendens*	1	4
8	*Tettigonia cantans*	2	8
9	*Ammophila sabulosa*	0	2
10	*Lasius niger*	0	1
11	*Dolichovespula media*	1	3
12	*Scolia maculata*	0	1
13	*Anoplius viaticus*	2	5
14	*Climbex femorata*	1	3
15	*Diprion pini*	1	2
16	*Philianthus triangulum*	2	8
17	*Dosypoda plumpis*	2	7
18	*Megachile centuncularis*	1	3
19	*Apis melifera*	1	4
20	*Apis melifera*	1	3
21	*Xylocopa valga*	0	2
22	*Bombus hortorum*	0	1
23	*Anomala dubia*	1	3
24	*Potosia lugubris*	2	4

To identify the effectiveness of educational field practice in zoology, quantitative and qualitative data from student trainees over the past two years were analyzed. The quality of knowledge, dynamics and results of the entrance and final tests were compared. The tasks of the entrance tests included testing in the zoology section, including materials from the school biology course; the final testing included questions in the discipline “Invertebrate Zoology” of the university course. Similar qualities were determined when studying the formation of research competencies of students in 2020 [7] and 2016 [8]. From this we can conclude that practical work and laboratory work have a positive effect on the formation of research competencies and the level of students shows high results (Table 1 a, b, c, d).

Table 1. Diagnostic of level of research competitions in different stages
Table 1a

Diagnostics of the level of research competence at the ascertaining stage (2021-2022)		
Tested skills	The number of correct answers	The number of errors
The ability to define concepts	10	11

The ability to classify	9	12
The ability to do conclusions	7	14

Table 1 b

Diagnostics of the level of research competence at the final stage (2021-2022)		
Tested skills	The number of correct answers	The number of errors
The ability to define concepts	14	7
The ability to classify	15	6
The ability to do conclusions	17	4

Table 1 c

Diagnostics of the level of research competence at the ascertaining stage (2022-2023)		
Tested skills	The number of correct answers	The number of errors
The ability to define concepts	12	9
The ability to classify	10	11
The ability to do conclusions	9	12

Table 1 d

Diagnostics of the level of research competence at the final stage (2022-2023)		
Tested skills	The number of correct answers	The number of errors
The ability to define concepts	16	5
The ability to classify	18	3
The ability to do conclusions	19	2

Figure 3. Indicators of ability at the start and finish of experiment

The process of the formation of research competence we have presented is not required for the use of students in all forms of educational activity. It is necessary to think through every step of his actions, build the educational process in this way. From the data presented, we see that the increase in the level of skills depends directly on the preparation of sutdens through laboratory work and educational field practices (Figure 3). It is necessary to build an educational process so that the student always experiences a situation of success. It is necessary to stimulate the formation of research competencies in various methods.

Based on the above data, we see that the number of correct answers increased by 4-8 percent after completing field training, respectively, the number of incorrect answers decreased. The ability to draw conclusions, define and classify and systematize information is directly related to the development of research competence. The difference in the average values in the 2021-2022 and 2022-2023 academic years may be due to distance learning during the quarantine period. According to data from sources [9], [10] and [11], there have been noticeable changes in the quality of knowledge and the percentage of student achievement since the pandemic. But at the same time, studies by H.Curtis [12] and I. Han [13] show that field training practice contributes to better assimilation of the material, which is confirmed by the test results. In the future, the prospects for research in the field of predisposition to biology have many prospects [14].

Conclusion. The field training in invertebrate zoology, which took place in 2021 and 2022 at the Higher School of Natural Sciences of Zhetysu University named after I. Zhansugurov, was successful. 2nd year students of specialty 6B01508 “Biology” were divided into several subgroups. Students were collecting invertebrate animals of the Insecta class in the city of Taldykorgan. A special feature of the work was the collection, classification and collecting of insects in the month of May for a visual study of the state of the fauna of the region. 4 expeditions were organized and 1 day was spent identifying and cassifying the caught specimens.

During field work, we consolidated the progressth theoretical material in practice and learned to independently organize, plan and conduct scientific and field work. We gained experience in working with entomological devices and orientation in the area, as well as searching for insects. While making a collection of invertebrate animals, we became more familiar with the anatomy and morphology of insects, as well as the rules for working with small animals. During field work, we observed species from the Apidae family and noticed the influence of geographical and climatic factors on the behavior of animals. We saw many biocenoses and ecological groups of animals.

The patterns of the food chain in nature and some features of the interaction of different species were noticed. Some bees from the family Apidae and wasps from the family Pompilidae have similar distribution areas and are found together in some grasslands. The peak activity of flying insects was established in the period from 13:00 to 15:00 Astana time. We assume that windless weather and direct sunlight play an important role in the composition of abiotic factors affecting invertebrate animals.

The work carried out shows that experience in the field and subsequent processing of material contributes to the development of students’ research competencies. A survey conducted at the beginning and end of field practice shows that the number of ideas and plans for research projects also increases after educational field practice.

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