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Research competence in the context of training future biology teachers

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Abstract

Relevance. The relevance of this study is due to the fact that in the process of implementing the competency-based approach, students' research activity becomes one of the leading ones in the structure of the future teacher's preparedness for professional activity.

Purpose. The purpose of this article is to reveal the process of formation of research competence in biology students in the process of mastering the discipline of "Biology Practice". The question of the formation of research competence is put forward as one of the most relevant requirements for graduates of higher education who train specialists in pedagogical specialties.

Methodology. In the course of the study, theoretical methods such as analysis, synthesis, generalization and empirical methods were used, consisting of questionnaires and tasks aimed at determining the level of experience in research activities, helping to consider the situation in the study of the formation of research competence of biology students, leading to a comprehensive review of the situation in the study of the formation of research competence in biology students.

Results. During the ascertaining stage of the study it was found that students have low and average levels of research competencies. To solve the problem of research training of biology students, a laboratory practice was developed and introduced into the educational process, by the end of which the students of the experimental group showed an increase in the level of research competencies. The role of laboratory practice in the formation and development of research activities of undergraduate biologists is determined. The data obtained are compared with international practice.

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Conclusions. The conducted research gives grounds to conclude that the developed laboratory practice helped students to master research competencies, which are represented by methodological knowledge and skills, as well as the technique of conducting the most important laboratory research.

Keywords: research activity; research competencies; laboratory competencies; activity component of research competence; educational process.

Introduction

The formation of research competence is one of the most important tasks of the education system of the Republic of Kazakhstan, since today the higher school is engaged in the implementation of the competency-based approach in education into practice. In view of improving the quality of education in the country, the need to strengthen the training of competent future teachers who are ready for successful professional and personal fulfillment becomes a priority.

Along with this, recently with the increased focus on the professional activities of teaching staff, much emphasis has been placed on the formation and development of research qualities of teachers. According to the legislation [1], there are several qualification categories of employees of the educational sphere, of which the highest level is occupied by the category of "teacher-researcher".

One of the criteria of this category is to ensure the development of students' research competencies. To accomplish these objectives, it is necessary to create a special formative environment in higher education, where the future teacher is given the opportunity to learn from personal experience the basics of research activities that lead to the formation of research competence.

The problem of the formation of research competence is not new, today there are a lot of studies on this issue, in which research competence in education is considered as the main component of the professional competence of a teacher [2-9].

Along with these studies, there are works devoted to the issue of the formation of research activity in teaching biology in higher education, which considers the process of forming research competence with the help of educational and research practice in botany [10-12], during field practice in natural sciences, in a university botanical garden, when organizing independent project-research activities [13; 14], in the study of insects [15-18].

The problem of formation of students' research competence is addressed by many Russian and local scientists. Thus, S.N. Lukashenko [19] considers research competence as an integral quality of personality, which is expressed in the ability and readiness to independently solve research problems and in the possession of research technology; as the necessary skills and experience for conducting research [7]; as the ability and readiness for research [8; 20; 21].

According to L. Agustin et al. [9], the main elements of research competence are a set of knowledge, skills and values. Based on the literature review, they determine the knowledge, skills and values that are part of the research competence.

Given the many definitions, in this article authors understand the research competence of an undergraduate biologist as the presence of a positive attitude and sustained interest of the student in research activities, possession of a set of necessary methodological knowledge and technologies of research activities, which is manifested

in the readiness and ability to conduct research on the study of living things.

However, the analysis of the above-mentioned works and the study of the state of the problem of training specialists in the field of biological education for research competence led to the conclusion that the role of laboratory practice classes in the formation of future biology teachers of research competence has not been disclosed.

The purpose of research is to study the process of formation of research competence in future biology teachers in the process of mastering the discipline of "Biology Practice".

Literature Review

In the works of scientists such as J.A. Skurikhina et al. [21], N.M. Edwards and S.I. Osipova [22], V.G. Sotnik [13; 23], A.D. Syzdykbaeva [24], T.A. Levchenko and L.E. Ageeva [25] research competence is considered in the categories of "activity", "research", "research activity". According to which the study of research activity is considered from different perspectives:

- formation of cognitive activity and motivation for research activities;
- increasing research interest when performing independent work, in order to increase the level of knowledge gained;
- organization of educational activities aimed at developing research competencies;
- drawing up a scientifically-based structure of the methodology of experimental research;
- development of creative activity aimed at solving problems and tasks of a research nature.

The authors consider research activity to be a necessary condition for the formation of students' research competence.

Through the engagement of students in research activities, research competence is formed and developed. To date, there are many definitions of the concept of "research activity". For example, in the works of A.V. Bagachuk and I.E. Kizelevich [26], research activity is understood as personally and socially significant cognitive activity that is carried out in the educational process of the university in accordance with the logic of scientific search, the product of which is subjectively new knowledge for the student about the object under study.

According to I.V. Kleshcheva and A.Sh. Bagautdinova [27] as the main features of research activity, they distinguish mastering by students not only factual knowledge, but also methods of active independent cognitive activity, disclosure and consideration of individual capabilities and characteristics of the student, as well as the presence of internal motivation and special structural components.

Thus, research activity presupposes the need for knowledge achieved in a specific field of research and the ability to independently extract new knowledge, apply it to

obtain new scientific knowledge based on personal experience.

The basis of research activity is the specific skills necessary to perform research tasks. The study and generalization of the literature on the topic of the study showed that there is no consensus on the definition of the concept of "research competencies". Based on the analysis of various definitions, authors have identified several approaches to the definition of "research competencies".

Next step would be to consider the most important definitions that were emphasized during study. I.A. Zimnyaya and E.A. Shashenkova [28] consider research competencies as the result of research activities that allow students to master the methods of scientific cognition in the course of educational activities, contribute to the development of interest and need for research activities. Under the research competencies N.O. Vaganova and V.M. Lopatkin [29] understand readiness for analytical mental activity, which is manifested in the ability to perform actions necessary to solve tasks or problems.

According to V.A. Anisimova and A.A. Nain [30], O.V. Bakhlova et al. [31], research skills are defined as the ability to take the actions necessary to perform research activities. Having studied a number of works and having defined the essence of the concept of "research competence", according to the logic of the study, authors reveal the features of the organization of the process of formation of the problem under discussion.

In modern literature, the idea of organizing students' research activities in biological disciplines through laboratory classes is traced. For example, D.I. Hanauer et al. [32] propose the introduction of short-term research into traditional laboratory classes, then G. di Trapani and F. Clarke [33] propose the creation of an introductory autonomous laboratory course, which is dedicated to the development of basic practical skills through the application of experimental methods used in biological sciences.

There is also the work of researchers, which suggests the development of research laboratory courses with distinctive features of the course research experience of students (discovery, iteration, collaboration) [34-37]. These researchers claim that laboratory work has a great opportunity in introducing students to science and is a valuable experience for them [34; 38].

The authors also point out that the participation of students in research laboratory courses has a significant impact on the continuation of a research career by students [35], and of course participation in research courses helps students achieve the same results as during a research internship [39-41].

The authors of recent publications have proven that students' participation in research and research experiences are fruitful for them, contribute to students' inclusion in the research community, and along with this it has been suggested that obtaining meaningful new discoveries can be an important factor in students' development of research skills [39; 42; 43].

Thus, the researchers identified the potential of laboratory classes, which can be used to form the research competence of biology students.

Materials and Methods

Spontaneous teaching of some research skills during traditional laboratory classes cannot serve as a basis for the formation of research competence. In this regard, for a deeper formation of research skills, it is necessary to introduce a special laboratory practice that allows not only detailed acquisition of knowledge in biological disciplines, but also mastering methodological knowledge and skills, as well as the technique of conducting the most important laboratory research.

Based on the research of scientists and own teaching experience, authors introduced the discipline "Biology Practice" into the educational process of the specialty "Biology", the content and structure of which is based on the provisions of the updated curriculum and the sequence of studying topics keeps a logical-systematic approach.

The formation of students' research competence occurs through the gradual development of its structural components – motivational, cognitive and activity components, where laboratory practice is an organizational form of their formation and development.

Since early publications discussed other components and criteria for the formation of the research competence of a bachelor biologist [44], in this article authors will focus only on the activity component and activity criteria, which are characterized by learned generalized methods of research activity, the basis of which are research skills. The study was conducted in the period from 2017 to 2020. The study involved 113 students of 1-3 years of the Korkyt Ata Kyzylorda University, specialty 5B011300-Biology.

Research competence diagnostics according to the activity criterion was focused on identifying the level of research skills and included the following methods: questionnaire "Possession of Research Knowledge and Skills" and performance of tasks to determine the level of experience in research activities.

During the survey, students were offered 10 statements and answers "I am unfamiliar with the subject", "I'm lacking in knowledge on the subject" and "I am well familiar with the subject". Each answer corresponded to a certain level of formation of research competence. For example, the answer "I am unfamiliar with the subject" corresponds to a low level; the answer "I'm lacking in knowledge on the subject" corresponds to medium level; the answer "I am well familiar with the subject" corresponds to a high level of formation of research activity.

Considering the opinion that students do not always adequately assess their achievements, additional diagnostics in the form of assignments were conducted to determine the level of personal experience in research activities.

During the assignments, students had to choose one of the proposed topics and determine and substantiate the scientific apparatus of the research work, draw up a plan of action and determine the methods of collecting information and processing the collected materials.

Each correctly defined item was evaluated with 1-3 points, the amount of points scored corresponded to a certain level of formation of research competence. Thus, 1-10 points – low level; 11-20 points – medium level; 21-30 points – high level of research experience for a bachelor biologist.

The choice of these methods is aimed at a more detailed diagnosis of the research activities of biology students during the study of the discipline "Biology Practice". Based on the above opinions of a number of scientists, by research skills authors mean students' knowledge of the methods of practical and intellectual actions that allow conducting research activities or its individual stages, and which are formed in the presence of appropriate knowledge, skills and abilities. Along with this, authors tried to identify the types of research skills that can be formed during the training of future biology teachers:

- the ability to see the problem, to put forward hypotheses, to plan a system of actions aimed at solving the problem;
- the ability to work with different sources of biological information;
- the ability to analyze and evaluate information, and to convert information from one form to another;
- the ability to identify, classify, compare and structure biological material;
- the ability to provide evidence, to identify a cause-and-effect relationship between living organisms and the environment;
- the ability to conduct observations and set up experiments to study the vital activity of biological objects;
- the ability to draw conclusions;
- the ability to ask questions, explain, prove, defend their ideas.

Results and Discussion

The study involved 113 students of 1-3 years of the Korkyt Ata Kyzylorda University, specialty 5B011300-Biology. According to the results of the questionnaire, it was found that students have a medium level of research skills (Figure 1).

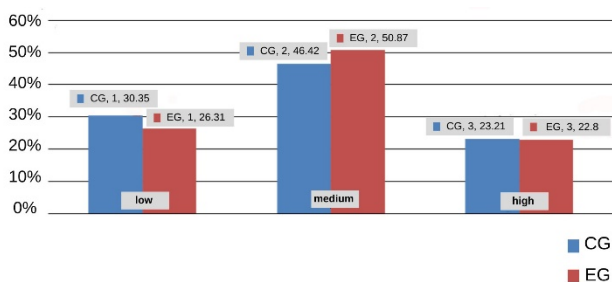


Figure 1. Students' self-assessment of their research competencies formation (%)

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

When summarizing the answers, it turned out that the students rated the following skills the lowest:

- to substantiate the research topic;
- to generalize and systematize the results of their own research activities;
- to select research tools and methods;
- to formulate conclusions and recommendations based on the results of the study.

Students gave higher rates to such skills of their as: to select the appropriate literature necessary to comprehend

the research topic; to conduct surveillance; carry out an experiment; to formalize research work in accordance with the relevant rules.

In order to fully diagnose and exclude inadequate assessment of indicators of the level of proficiency in research skills of the activity criterion of research competence, an additional study was conducted to identify the presence of experience in research activities among biology students (Figure 2).

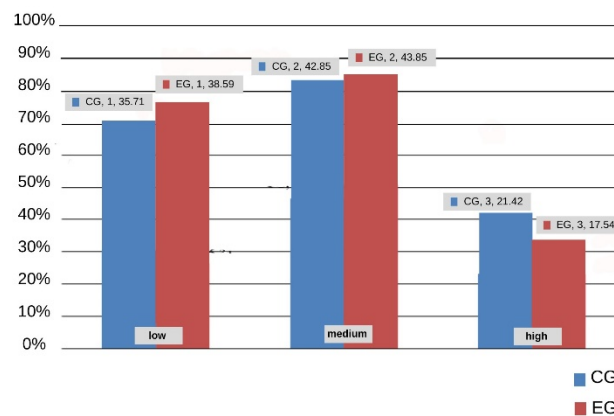


Figure 2. Levels of experience in research activities (%)

The results of the assignment showed that most students in both groups are unable to substantiate the relevance of the research, define the purpose and objectives of the study, identify research methods and the significance of the research, as well as identify methods of collecting information and processing the collected materials. The analysis of the results of the questionnaire and the assignment showed the predominance of low and medium levels of research competence and the need to implement the "Biology Practice".

The purpose of laboratory practicum was to give students the opportunity to master the basic methods used in science in general and biology in particular, both independently and by working in a group. The laboratory workshop was organized for 3rd year students who already have some experience in research activities.

Since at the ascertaining stage of the study the results of students with low and medium levels were analyzed, according to which it was revealed that the subjects are able to independently apply the acquired knowledge in familiar conditions of activity for them, but have difficulties in applying knowledge in a new situation, and the task requires the participation of a teacher, the tasks authors developed were focused on greater independence of students.

In order to achieve the goal and set tasks for the formation of research skills, students, in addition to independent work, also performed group tasks, during which they applied in practice theoretical and empirical biological research such as observation, experiment, analysis, comparison, finding cause-and-effect relationships, putting forward new hypotheses, modeling.

The results of repeated diagnostics of the activity criterion of research competence of biology students after studying the course "Biology Practice" showed the effectiveness of the methodology used and an increase in the level of research skills, the interpretation of which is

presented below. The results of the questionnaire to identify the level of operating research skills are shown in Figure 3.

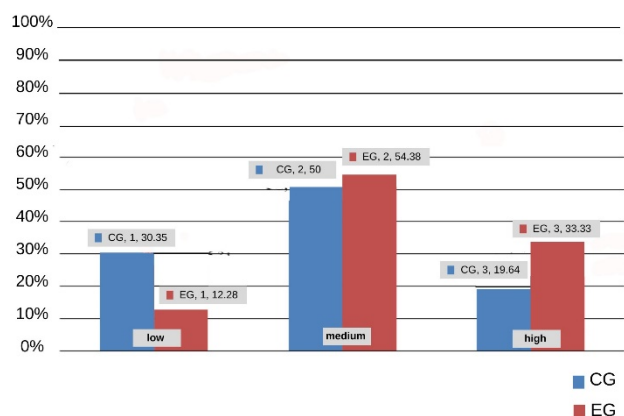


Figure 3. Students' self-assessment of their research competencies formation (%)

When interpreting the answers, it turned out that the students rated the following skills the lowest: to substantiate the research topic; to generalize and systematize the results of their own research activities. In their answers, the students gave a higher rating to following skills: to select the appropriate literature necessary for understanding the research topic; to select research tools and methods; to conduct observation; to carry out an experiment; to formalize research work according to the appropriate rules; to formulate conclusions and recommendations based on the results of the study.

According to students' self-assessment, it is possible to state the predominance of medium and high levels of research skills among students of the experimental group. A comparative analysis of the indicators of both groups at the beginning and at the end of the pedagogical experiment showed the following picture (Table 1).

Table 1. Comparative survey indicators at the beginning and at the end of experimental work

Levels	Control group				The difference in results %	Experimental group				The difference in results %
	Ascertaining experiment		Control experiment			Ascertaining experiment		Control experiment		
	qty	%	qty	%		qty	%	qty	%	
Low	17	30.35	17	30.35	0	15	26.31	7	12.28	-14.03
Medium	26	46.42	28	50	3.58	29	50.87	31	54.38	3.51
High	13	23.31	11	19.64	-3.67	13	22.8	19	33.33	10.53

The results of the control stage of the study revealed an improvement in the indicators of the experimental group: a decrease in the number of students who possess research skills at a low level (by 14.03%) and an increase in the indicators of the medium by 3.51% and the high level by 10.53% compared with the ascertaining stage of experimental work. The same result was shown by a repeated task to identify the presence of experience in research activities among biology students (Figure 4).

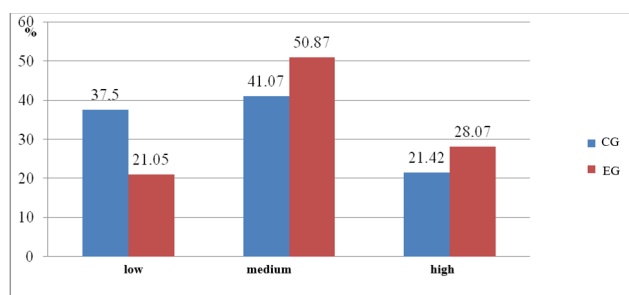


Figure 4. Level of experience in research activities (%)

The interpretation of the results of the task revealed an improvement in the definition and substantiation of the scientific apparatus of the research work of the students of the experimental group compared with the data of the ascertaining phase of the study. When analyzing the answers, it was determined that the control group students find it difficult to determine the relevance, hypothesis, goals and objectives, as well as the theoretical and practical significance of the study.

All respondents of the experimental group easily coped with drawing up an action plan and determining the method

of collecting and processing information, which indicates the formation and development of students' ability to research. The results of the control stage of the experiment allowed to state a deeper formation and development of research skills among students who studied in the experimental group.

Naturally, the formation of research skills does not happen immediately. It requires a lot of repetition. In their work G. di Trapani and F. Clarke [34] point out that most students achieved competence in laboratory exercises after the first classes, while others needed more time and repetition to achieve the same result.

The process of forming students' research skills was under the constant supervision of teachers in the classroom, and was also analyzed based on the results of student feedback, which was organized after each lesson, and by the results of the midterm examination.

According to observations, by the end of the semester, most of the students were ready and able to independently apply theoretical knowledge to perform research tasks, that is, they moved from the medium level to the high level. A similar result is noted in the work of D.R. Caprette et al. [45], where, after a modular laboratory course, students achieved various levels of competence.

Conclusions

The research competence of biology students is one of the main elements of their future professional activity and is the result of competently planned research activities. For the formation and development of research competence of biology students authors have developed and implemented in the educational process laboratory practice, which

allowed to master the methodological knowledge and skills, techniques of the most important laboratory research, the effectiveness of which has been proven in the scientific research.

During the practice, students were presented with individual and group tasks aimed at forming research activities. Summing up the results of the work done, it can be stated that the methodology used by the authors, aimed at establishing research activities among future biology teachers, has yielded positive results.

According to the students' self-reflection at each lesson, their skills became clearer and distinct, they began to understand what they were doing, how they were doing and why they were doing, which was confirmed by the results of the midterm examination and the results of the control

stage of the study. Undoubtedly, this research will contribute to solving the problems of formation and development of research competence among biology students. Further research may be related to the development of the idea of forming research competence in teaching other biology disciplines and the creation of methods for its implementation.

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Conflict of Interest

None.

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Компетентність у дослідженнях у контексті навчання майбутніх вчителів біології

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Анотація

Актуальність. Актуальність дослідження полягає в тому, що в процесі впровадження компетентнісного підходу діяльність студентів у сфері наукових досліджень стає однією з провідних у структурі підготовки майбутнього вчителя до професійної діяльності.

Мета. Метою цієї статті є розкриття процесу формування дослідницької компетентності у студентів біологічних спеціальностей у процесі вивчення дисципліни "Практика біології". Питання формування дослідницької компетентності висувається як один із найбільш актуальних вимог до випускників вищої освіти, які підготовлюють фахівців педагогічних спеціальностей.

Методологія. У ході дослідження були використані теоретичні методи, такі як аналіз, синтез, узагальнення, та емпіричні методи, що включали анкетування та завдання з метою визначення рівня досвіду у науковій діяльності, що допомогли розглянути ситуацію у вивченні формування дослідницької компетентності у студентів біології, що призвело до комплексного огляду ситуації у вивченні формування дослідницької компетентності у студентів біології.

Результати. Під час констатуючого етапу дослідження було встановлено, що студенти мають низький і середній рівні дослідницьких компетентностей. Для вирішення проблеми дослідницької підготовки студентів біології була розроблена та впроваджена лабораторна практика, під час якої студенти експериментальної групи показали зростання рівня дослідницьких компетентностей. Визначено роль лабораторної практики у формуванні та розвитку дослідницької діяльності студентів-біологів. Отримані дані порівнюються з міжнародною практикою.

Висновки. Проведене дослідження дає підстави зробити висновок, що розроблена лабораторна практика допомогла студентам оволодіти дослідницькими компетентностями, які представлені методологічними знаннями та навичками, а також технікою проведення найважливіших лабораторних досліджень.

Ключові слова: наукова діяльність; дослідницькі компетентності; лабораторні компетентності; компонент діяльності дослідницької компетентності; освітній процес.