Project title: ИРН № AP14869376 Development of interdisciplinary research ability of students in the implementation of synergetic education in higher education.

Relevance: The modern economy is increasingly in need of specialists with deep knowledge and capable of innovation. Therefore, the work on the development of students ' research ability is a necessary element of the modernization of the economy of the Republic of Kazakhstan. A special place is taken in the system of training creatively working highly qualified specialists, their readiness to effectively conduct interdisciplinary research in various sectors of the country's economy. One of the main conditions for implementing a technological breakthrough in the economy of the Republic is the following: Kazakhstan needs to create a core of national intelligence. This core should consist of erudite people who are profoundly proficient in integrated natural science, technical and humanitarian knowledge. These people must have the knowledge and skills of interdisciplinary research and be able to compete in the global technological space.

Research activities of students are an integral part of the training of future specialists. It is also implemented in the joint educational, scientific and industrial activities of a teacher and a student in the context of integration of disciplines that are studied in the higher education system.

However, there are a number of problems in the development of research activities of future specialists. First, the process of forming interdisciplinary research abilities of students in various Sciences has not been sufficiently studied. Secondly, methodological tools and approaches are still poorly understood. They should contribute to the effective formation of interdisciplinary research activities of future specialists. The optimal solution to this problem is possible in the conditions of implementation of synergetic education at the University. To do this, you need to create a educational environment . It will contribute to the development of interdisciplinary research abilities of students based on the study of the theory of self-organization (synergetics).

The results of the analysis of further self-determination and self-affirmation of young professionals indicate their weak abilities in the field of interdisciplinary research. Today, there is a low level of professionalism in the majority of graduates of technical universities. Kazakhstan needs highly qualified engineers and scientific and technical personnel with interdisciplinary knowledge and skills and creative thinking.

Early identification, training and education of talented students is a new task for improving the country's education and science system. Highly qualified specialists solve scientific and technical problems of modern society in the conditions of its industrialization. It also provides opportunities for intensive social and scientific-technical progress, further development of science and culture, all areas of production and social life.

We plan to investigate this problem in the context of implementing synergetic education at the University. Synergetic education involves the reflection of ideas of self-organization in existing educational programs and the introduction of special disciplines in educational programs. These programs reveal the main provisions of synergetics and its ideological, educational and developmental functions. One of the important conditions for implementing synergetic education is to update the content of natural science subjects. The fundamental basis of synergetics is natural science.

Project goalis to design the content of synergetic education at the University. It is intended to study the basics of the theory of self-organization in the context of the implementation of integration of various disciplines and develop.

Expected and achieved results in accordance with the requirements of the tender documentation and the specifics of the project:

1. the field of application and target consumers will be students, undergraduates and doctoral students, as well as researchers. They use the ideas of synergetics in interdisciplinary research activities;

2. the expected results create conditions for the integration of various University disciplines and affect the development of interdisciplinary research ability of students. These activities are necessary for students to conduct research based on a synergistic approach at the junctions of various Sciences;

3. scientific results of the project will be used in the field of natural science research, as well as in Economics, sociology and history;

4. research results will be distributed at the level of scientific and methodological seminars, conferences and round tables.

As a result of the completed scientific research will be:

1. the concept of synergetic education was created. The concept is aimed at forming an interdisciplinary research ability of future specialists of the University.

2. the state of development of interdisciplinary research in higher education of the Republic of Kazakhstan is analyzed; the analysis of the state of implementation of the basics of synergetics in the education system of the country and the education system of the near and far abroad is carried out.

3. created a educational environment for preparing students for interdisciplinary research activities based on the study of the theory of self-organization: created a didactic learning system (DLS). It is necessary to implement interdisciplinary research in the context of the implementation of the synergetic education in high school:

a) introduced in the educational process of the University elective special course "synergetics – an interdisciplinary scientific theory";

b) open research center, "an Interdisciplinary study of socio-natural systems" and the student's interdisciplinary experimental laboratory.

4. scientific achievements of the theory of synergetics are used to improve the quality of pedagogical measurement of student learning outcomes.

5. scientific products of students on the basis of the student experimental interdisciplinary laboratory and circles of the University:

a) scientific projects will be prepared for student conferences, monographs and textbooks;

b) the creation of devices, technical equipment and computer programs. They identify synergistic effects in physical, chemical, biological, economic and social processes;

c) author's certificates for scientific products on synergetic research have been obtained;

6. at least 1 (one) article or review in a peer-reviewed scientific publication indexed in the Social Science Citation Index, Arts and Humanities Citation Index and (or) Russian Science Citation Index of the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty-five);

- as well as at least 2 (two) articles and (or) reviews in peer-reviewed foreign and (or) domestic publications recommended by Committee for Quality Assurance in the Field of education and Science of the Ministry of Education and Science of the Republic of Kazakhstan;

Scientific results obtained under the project for 2023

1 task. To develop a concept of synergetic education aimed at the formation of interdisciplinary research ability in future specialists of the university.

The work done. The concept was created and the structure and content, purpose and objectives, methodological basis of synergetic education aimed at the formation of interdisciplinary research ability of future specialists of the university were revealed.

It proves that the implementation of synergetic education in higher education contributes to the modernization of education and the integration of natural sciences and humanities. Domestic and foreign scientific works on the development of students' research activities have been studied.

The priority goal of this concept is the formation of a developed personality who can think on a national and planetary scale, act in non-standard situations and be in harmony with the surrounding world.

The article "The concept of synergetic education in the context of integration and modernization of the content of natural sciences and humanities" was published by the authors: Mukushev Bazarbek Agzashuly, Mukushev Abzal Bazarbekovich, Bazarbekova Aizhan, Omarova Nuria Moldagalievna

2 task. Analysis of the state of development of interdisciplinary research in the university system of the Republic of Kazakhstan; comparative analysis of the state of implementation of synergetic elements in the domestic education system and the education system of the near and far abroad.

The work done: The concepts of interdisciplinarity and interdisciplinary research are revealed, the state of development and the results of interdisciplinary research in the university system and research institutes of the Republic of Kazakhstan are studied.

A comparative analysis of the state of the introduction of synergetic elements into the domestic education system and the education system of the near and far abroad is carried out. Based on the study of statistical data on the state of synergetic research, the main directions of the development of interdisciplinary research based on the synergetic approach in education are identified. These areas are the following:

1. Students study special elective courses with interdisciplinary content and reflecting the main provisions of the theory of self-organization (synergetics) in this course;

2. The opening of interdisciplinary laboratories on the basis of higher educational institutions aimed at conducting interdisciplinary research from the perspective of the following sciences: physics, chemistry, biology, computer science, economics, etc.

3. Opening of the student interdisciplinary circle. In this circle, students will create projects for speaking at scientific conferences and competitions, design various devices with synergetic effects, write articles for student conferences and scientific journals.

3 task.. To create an educational environment to prepare students for interdisciplinary research activities based on the study of self-organization theory.

Scientific results: The educational environment of students' preparation for interdisciplinary research activity on the basis of studying the theory of synergetics was created. The structural elements of this educational environment were defined and created: didactic system of training (DST), which consists of forms, methods, technology and means of training; The content of synergetic education was constructed on the basis of implementation of elective course

"Synergetics - interdisciplinary scientific theory"; The scientific center "Interdisciplinary study of socio-natural systems" and student experimental interdisciplinary laboratory were opened.

4 task. To apply the scientific achievements of synergetics theory to improve the quality of pedagogical measurement of students' learning outcomes.

Scientific Results: The patterns and principles of synergetics will be used to improve the quality of pedagogical measurement of students' and pupils' learning outcomes. The information entropy formula, which is derived from the theory of synergetics, will be used in the processing of testing results. Scientific tools of synergetics will be used in the implementation of multilevel form of control of students' learning activities.

5 Task. To open on the basis of universities student experimental interdisciplinary laboratories and circles; to issue scientific products (scientific articles, monographs and textbooks) and create devices, technical equipment and computer programs based on the identification of synergetic effects in physical-chemical, biological, economic and social processes; to obtain copyright certificates and patents for scientific products on synergetic research;

Scientific results:

Opened on the basis of KazATU interdisciplinary laboratory aimed at conducting interdisciplinary research from the position of the following sciences: physics, chemistry, biology, informatics, economics, etc.

Student interdisciplinary circle with the name "Modeling of synergetic systems" was opened on the basis of KazATU. In this circle students will create projects for presentation in scientific conferences and competitions, design various devices with synergetic effects, write articles for student conferences and scientific journals.

Under the guidance of the Project supervisor Mukushev B.A. Mukhametkazina A.S., 2nd year student. (Faculty of Agronomy, group 01-077-21-02), a member of the circle "Modeling of synergetic systems" made a report on "Synergetic regularities of populations of two biological species in the ecological system" in the International Scientific and Practical Conference "Seyfullinskie readings: "Science xxi century - the era of transformation" 2022, October 6, KazATU Astana and her report was published in the conference book.

The following articles were published:

Mukushev Bazarbek Agzashuly, Mukushev Abzal Bazarbekovich, Bazarbekova Aizhan, Omarova Nuriya Moldagalievna **"The concept of synergetic education in the conditions of integration and modernization of the content of natural sciences and humanities disciplines".** Vestnik nauki № 36(259) October 2022. Moscow.

Mukushev Bazarbek Agzashuly, Mukushev Abzal Bazarbekovich, Bazarbekova Aizhan, **"Issues of development of students' interdisciplinary research activity"** Vestnik nauki № 36(259) October 2022. Moscow.

S.B. Mukushev, B.A. Mukushev, A. Bazarbekova. **"Realization of integrative learning on the basis of the theory of synergetics" Bulletin of ENU (series of pedagogy**) 2022 №3

Mukhametkazina A.S. (2nd year student Agronomic faculty) "**Synergetic regularities of populations of two biological species in the ecological system"** in the collection of "International Scientific and Practical Conference "Seifullinskie readings : "Science xxi century - the era of transformation" 2022, October 6, KazATU Astana)

Mukushev, B. A., Mukushev, S. B., Mukushev, A. B., Erkebulan, G. T. **Orta mekteptің informatika pәni boyynsha akparattyқ theory negizderin okytu [Matin]** // "Bilim" ғылыми-

pedagogical journals. - Astana: Y. Altynsarin atyndagy Ұlttyқ bilim academy, 2023. - №2. - Б. 91-96.

A training manual and a textbook were published:

Mukushev B.A., Turdina A.B. **"Fundamentals of information theory**". Astana. - KazATU 2022. - 112 c.

Mukushev B.A., Kismanova A.A., Mazakova B.M. **Fundamentals of digital electronics. Part** 1. 2023. Textbook. 152 c.

Journals included in the COCCHE list

Mukushev S.B., Esekeshova M.D., Mukushev B.A., Zamanbekova J.S., Bazarbekova A. **Synergetics ilimi negizinde panderdi integratsilap okytudy iske asyru. Bulletin of ENU (pedagogy**) 2022 № 3 P. 268-277 (KOKSNVO).

Bazarbekova A., Mukushev B.A., Mukushev S.B. **Akparattyk synergetics negizderimen bilim alushylardy tanystyru** // Bulletin of ENU (pedagogy) 2022 № 4 p.51-66 (Koksnvo)

Mukushev B.A., Kiyan V.S. Myrzagalieva A.B., Mukushev A.B., Turlybek N.V. **Microagzalarlardyң populationsyn zertteude modelder madisyn koldanu** Bulletin of ENU (Biology) 2021 № 4 6-16 bet (KOCSNVO).

Mukushev B.A. **Energy picture of the gravitational field of the Solar Syste**m // Bulletin of KazNU (Physics) 2022 № 4. C. 59-66. (KOCSNVO)

Mukushev B.A. **Computational experiments on the study of celestial mechanics** // Bulletin of KazNU Physics Series 2023 №2 p. 49-58. 49-58. (COKSNVO)

Mukushev B.A., Mukushev S.B. Myrzagalieva A.B., Prmantaeva B.A. Omarova N.M. **Ecological tizbekter zhane olardyң mathematical and computer modeleri** // Bulletin of ENU (Biology) 2023 № 2 54-65 bet (KOCSNVO).

The following copyright certificate was obtained:

Bazarbekova Aizhan, Mukushev Bazarbek Agzashuly, Mukushev Abzal Bazarbekovich. **Test natizheleri boyynsha contestқ oryndardy anyktauda akparattyқ entropyany koldanu" (EEM- ға arnalgaan bagdarlama) Ministry of Justice of the Republic of Kazakhstan** № 35813 May 17, 2023.

Bazarbekova Aizhan, Mukushev Bazarbek Agzashuly, Mukushev Abzal Bazarbekovich. **"Kazak, orys and agylshyn tilinde berilgen maitindegi әripterdiң salystyrmaly zhiligin anyқtaudyң computerik әdisi" (EEM- ға arnalған bagdarlama) Ministry of Justice of the Republic of Kazakhstan** № 35812 May 17, 2023.

The following patents have been obtained:

1. *Mukushev Bazarbek Agzashuly* № 8371 Experimental tool for obtaining the central force with the help of magnetic field. 2023.
2. *Mukushev Bazarbek Agzashuly, Mukushev Abzal Bazarbekovich* № 8568 Generator for obtaining nonlinear electric auto oscillations. 2023.

The following devices and equipment are made:

1. Generator of nonlinear electrical auto oscillations.
2. Generator of relaxation electrical auto oscillations.
3. Experimental installation for studying the motion of a body under the action of central pressure. 4.
4. Temperature meter on Arduino microcontroller. 4.
5. Voltage meter on microcontroller Arduino

The following scientific works of students of the circle took prize-winning places at the competition NIRS KazATU, the first work - at the national competition 2 place.

1. "Investigation of body motion in the field of central force by means of natural and computer experiments" group 05-057-21-07 students Kaliev Raim, Baltabaev Damir. (Section: Physics and Astronomy) 1st place;

2. "Microorganismder populationasynyң mathematical and computer modeleri. 05-057-20-09 group, student Aybat Nurai Aybatkyzy (Section: Mathematical and Computer Modeling) Faculty of KSIPO

Members of the research group:

project manager – Mukushev Bazarbek Agzashuly, Doctor of Pedagogical Sciences, Professor.ORCID: https://orcid.org/0000-0001-8015-1586,ScopusID: 55946647200, ResearcherID: U-7785-2018

research group:

Chief Researcher–Mukushevabzalbazarbekovich, ResearcherID: U-9520-2018, ORCID: https://orcid.org/0000-0001-5322-150X

Senior Researcher–Bazarbekova Aizhan, ORCID: https://orcid.org/0000-0001-7356-3603 , ResearcherID: U-9684-2018

Senior Researcher–Omarova Nuria Moldagalievna,Web of Science ResearcherID:O-7583-2016

Researcher–Kerimbayev Aibek Orazgalievich, ORCID: https://orcid.org/0000-0002-5920-9998 , ResearcherID:AAM-9724-2021 E

Turbin Almaz Bidakhmetovich - Junior Researcher

Information for potential users:

The central place in our research is occupied by the educational environment, designed to promote the formation of interdisciplinary research activities of future specialists in conditions of synergetic education.

The educational environment should facilitate students to receive the following scientific products:

- research projects for various scientific student conferences;
- publish articles in journals and collections;
- to create devices and equipment and computer programs based on the identification of synergistic effects in various phenomena;
- get copyright certificates for scientific products.

Additional information:

Our research can solve the main problems of training future specialists to work in high-tech industries of national production. It is known that most universities work according to a training system based on the disciplinary organization of science, which is aimed at training graduates of educational institutions of narrow specialization. Today's realities of the development of world society and the economy dictate the need to train broad-profile specialists with interdisciplinary knowledge and skills. These specialists are always in demand in industries where knowledge and skills from the field of various sciences are needed. As a result, our specialists can be recognized and recognized internationally. This factor should strengthen the image of our country in the global community.

The optimal solution to this problem is possible under the conditions of a systematic approach, that is, it is necessary to create an educational environment designed to promote the formation of interdisciplinary research activities of future specialists.