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INTERDISCIPLINARY INTEGRATION OF SCIENCE EDUCATION AT HIGHER EDUCATION INSTITUTION

Polina Dmitrievna Vasilyeva (a)*, Viktoriia Stanislavovna Tugulchieva (b), Renat Aleksandrovich Bisengaliev (c), Ol'ga Viktorovna Khongorova (d), Natal'ya Yur'evna Tulina (e), Yuliya Andreevna Skidanova (f) *Corresponding author

(a) Kalmyk State University named after B.B. Gorodovikov, Elista, Russia, vasilyeva_pd@mail.ru

(b) Kalmyk State University named after B.B. Gorodovikov, Elista, Russia, tugvicky@yandex.ru

(c) Kalmyk State University named after B.B. Gorodovikov, Elista, Russia, rinus5637@mail.ru

(d) SFA of EMERCOM of Russia, Moscow, ov.khongorova08@yandex.ru

(e) Kalmyk State University named after B.B. Gorodovikov, Elista, Russia, stepnay-cat@mail.ru

(f) Kalmyk State University named after B.B. Gorodovikov, Elista, Russia, youliya0685@mail.ru

Abstract

The article deals with the actual problem of an interdisciplinary integration of knowledge in modern higher education institution taking into account the strengthening of integration processes in science and education, the emergence of new academic disciplines reflecting the renewal of natural science knowledge and methods of its application. Socio-economic, scientific and technological transformations of society dictate the requirements for the formation of systemic knowledge of students. An interdisciplinary integration as a way to achieve the systematicity of students' natural science knowledge is caused by the growth of educational information, its poor structuring in information sources, insufficient interconnectedness of academic disciplines. The article analyses the problem of implementation of the interdisciplinary integration of content and teaching methods in students' natural science training. The problem is considered from the point of view of the analysis of the components of the integrative approach implementation: organisational-methodological, activity-practical and theoretical-content. In science, the processes of a knowledge integration have been studied in the framework of the system approach, and the methodological foundations of the integration have been defined in the system of science education. The analysis of studies on the implementation of an interdisciplinary integration of knowledge in higher education reflects the problems of insufficient development of the theory of interdisciplinary studies. The authors substantiate the choice of content and methods of the interdisciplinary integration of students' knowledge, corresponding to the dynamics of knowledge development in science and science education.

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1. Introduction

An integration is the process and result of interconnection and synthesis of heterogeneous knowledge about the world. It is aimed at overcoming the fragmentation and fragmentation of students' knowledge. The processes of integration and differentiation of knowledge have been studied in gnoseology, methodology of systemic research, psychology and didactics. Teachers address to the problem of the interdisciplinary integration is connected with the need to form systematic knowledge.

The systemacity of learners' knowledge is considered as a quality of the totality of knowledge and is characterised by the presence in the mind of structural and functional links between heterogeneous elements of knowledge (Bim-Bad, 2002).

In didactics of teaching, types of interdisciplinary links have been identified: content, functional, structural-organisational, and others. In domestic pedagogy, integration was studied from the position of applying a systematic approach to the organisation and process of learning, and the integration of knowledge and methods was presented as more than the sum of knowledge and skills, providing "increment" in understanding the studied subject. Analysing the state of the integration problem, T.S. Nazarova and V.S. Shapovalenko identify external and internal cognitive barriers in learning, in particular, the discrepancy between the content of natural science disciplines and the achievements of science, which entails an increase in the complexity of the material (Nazarova & Shapovalenko, 2003).

In the theory and practice of school education, the term "interdisciplinary links" is firmly established; in the university system, the term "interdisciplinary links" acts as a didactic principle in the theory of teaching and a condition for the formation of systemic knowledge of students. The interdisciplinary course "Concepts of modern natural science" is studied in the process of teaching students in higher education (Grevtseva et al., 2017).

In pedagogical science, the problem of the interdisciplinary integration of students' knowledge has been investigated, heterogeneous types of the interdisciplinary integration are implemented at school at the levels of content, teaching methods and technologies, organisational forms of learning. The metamethodological approach, which combines private methods of teaching schoolchildren on an integrative basis for the formation of systemic and effective knowledge of students, has been developed in domestic education (Titova, 2004).

In the practice of student education, interdisciplinary integration has been developed in connection with the spread of project and research methods, with the widespread introduction of the competence approach, bringing together different areas of students' professional training (Shumilina & Antsiferova, 2024).

In the theory of higher education the problem of the interdisciplinary integration is insufficiently researched, it requires analysis and differentiation of concepts such as transdisciplinarity, interdisciplinary synthesis, integrated approach. Such philosophical problems as dialectical interrelation of integration and differentiation of knowledge in the period of strengthening integration processes in society and education, limits of integration and conditions of its implementation are understudied.

Researchers note the relevance of establishing the interdisciplinary integration of the content and methods of student learning for the formation of competencies of students, the development of new

scientific disciplines, the implementation of the development strategy of modern higher education on the connection of educational and professional standards in training areas (Zinchenko, 2020).

The interdisciplinary integration can be subject to the already formed basic knowledge within the discipline-organised education. The analysis of foreign literature has shown that its supporters see the need to erase the boundaries of discipline-based organised learning as not corresponding to modern realities (Jacob, 2015; Repko, 2011). Therefore, the influence of integration on the development of cognitive abilities has been studied (Tomakova et al., 2018), while the proponents of the interdisciplinary integration note empiricism in the approach of educators to their choice and define their implementation as eclecticism (Petrova, 2008).

Shestakova L. A. believes that representatives of academic pedagogical science and practice have not developed a common understanding of such concepts as "interdisciplinarity", "interdisciplinary approach", "interdisciplinary integration" (Shestakova, 2013). There is also a lack of a holistic approach to the methodology that embodies the ideas of the interdisciplinary integration in the modern educational process (Shestakova, 2013). The practice of implementation of the interdisciplinary integration in student training, while maintaining the existing structure of disciplinary organisation of training, faces its insufficient research in terms of integration of content and methods of student training.

2. Problem Statement

Let us consider the problem of implementation of the interdisciplinary integration of content and teaching methods in science education, as a way of forming system knowledge of students majoring in natural science, at the organisational-methodological, activity-practical and theoretical-content levels (Singh et al., 2024; Tang & Yang, 2024).

3. **Research Questions**

The problem of realisation of the interdisciplinary integration in students' natural science education is being solved in higher education institutions to varying degrees of success:

At the organisational and methodological level, the implementation of the interdisciplinary integration: research methods, in particular, the project method, which bring together different areas of students' professional training, has become widespread in the training of university students. The condition for the application of these methods is a comprehensive analysis of the research object from different positions, including interdisciplinary connections. These methods were actualised with the introduction of the competence approach to the development of students' research skills (Noskov & Shershneva, 2008). Despite the large number of publications on the project method, the diagnostics and criteria for assessing interdisciplinary links and the ability to establish them in the process of learning topics are insufficiently researched. The teaching methodology identifies types of interdisciplinary links: content, functional, structural-organisational, etc. In the practice of the educational process in HEIs, the most actively developed ones are structural-organisational (in the form of network interactions between HEIs, academic exchange and internationalisation of students). The less developed ones are substantive and functional. It is the latter types of interdisciplinary links that are the object of our research and seem

to us significant for the formation of universal competences, which are known to be integrative in nature. The practice of implementation of the interdisciplinary integration in students' training while maintaining the existing structure of disciplinary organisation of education faces its insufficient research (Regnerová et al., 2024; Waite, 2024).

At the activity-practical level, the implementation of the interdisciplinary integration requires justification of the content in terms of criteria, types and forms corresponding to the new requirements of students' professional training. The interdisciplinary integration is realised through the application of methods and techniques of forming systemic knowledge of students. In the educational process, the establishment of interdisciplinary links is carried out through the introduction of situational tasks in the training of students using contextual learning, in the application of the technology of enlargement of didactic units.

Researchers consider mathematics as a basic discipline for the integration of science education (Noskov & Shershneva, 2008; Tugulchieva & Vasilieva, 2017). Taking into account the role of calculations in the professional activity of natural scientists, the methodological basis of complexes of educational and cognitive interdisciplinary tasks can be the method of mathematical modelling as a universal method of mathematics, suitable for studying processes in natural sciences and teaching (Noskov & Shershneva, 2008).

At the theoretical and content level, the implementation of the interdisciplinary integration determines the reference to the formation and development of the system approach in pedagogy, to the problem of updating the content of science education with synergetic ideas, as well as the possibility of establishing interdisciplinary links.

In the theory of cognition and system approach, the concept of "system", "integrity" only in the 80s of the 20th century came to the concept of "integration". The levels of knowledge integration in science education have been identified: intra-subject, inter-subject and the level of interdisciplinary synthesis. In higher education, the turn to the problem of interdisciplinarity is associated with the development of the synergetic concept of self-organisation, and the interdisciplinary integration was considered as a non-classical form of fundamentalism and modern science and university education (Tyukhtin, 1988).

The methodology of implementation of the interdisciplinary integration is conditioned by the unity of the world, the complex nature of solving the problems of worldview, global problems and their reflection in education, the transition of the education system to the post-non-classical period of development. The interdisciplinary integration as a way of formation of system knowledge by students of natural science directions of training is carried out in higher education institution taking into account subject areas and reliance on the fundamental nature of natural science (Zorina, 1993).

The interdisciplinary integration was seen as a non-classical form of fundamentality and modern science and university education. In higher education, the turn to the problem of interdisciplinarity is connected with the development of the synergetic concept of self-organisation as a field of interdisciplinary knowledge for the analysis of pedagogical systems as an open, non-linearly developing complex system.

4. Purpose of the Study

The purpose of the work is to justify the choice of content and methods of the interdisciplinary integration of students' knowledge, corresponding to the dynamics of knowledge development in science and science education.

5. Research Methods

To achieve the objective of the study, the following was implemented:

- i. The plan of diagnostics of knowledge quality for the whole period of the study using the developed diagnostic materials was established.
- ii. Theoretical analysis of the investigated influence of the integrative approach on the improvement of knowledge quality was carried out.
- iii. The thesaurus approach was applied to establish the relationship of general scientific concepts for students of natural science.
- iv. The analysis of the content of subject areas was carried out taking into account the stage of systematisation, generalisation and establishment of interdisciplinary links in the study of profile disciplines.
- v. The selection of methods (mathematical modelling method and task method) and technologies (A.A. Verbitsky's contextual learning, P.M. Erdniev's enlargement of didactic units, L.S. Ilyushin's compilation of tasks with the help of constructor) is aimed at integration of knowledge. This involves ways of activity and most converging professional areas of students' training in science education with the integrative role of mathematics.

6. Findings

- i. Justification of the interdisciplinary integration of knowledge by introducing synergetic ideas in the training of chemistry teacher for students, updating the content with synergetic concepts.
- ii. Justification of application of the technology of didactic units enlargement for integration of knowledge and adaptation of foreign students of natural sciences.
- iii. Refinement and completeness of the systematisation of types of the interdisciplinary integration.

7. Conclusion

The interdisciplinary integration of knowledge is recognised by researchers as relevant, and its implementation in modern education is in demand for solving a number of problems: formation of systemic knowledge, holistic worldview, development of cognitive abilities, development of competencies in the process of students' mastering educational programmes

The analysis of the problem of the interdisciplinary integration shows that the most significant one becomes the establishment of functional and substantive links of content. Interdisciplinary links in the educational process require active cognitive activity, ways of organising such activity.

The method of mathematical modelling applied in various natural science disciplines "Physics", "Chemistry", "Biology" for building mathematical models of the phenomena under consideration (physical, biological, chemical) is studied. The task approach is implemented in the process of composing tasks in teaching mathematics and chemistry using technologies of enlargement of didactic units by P.M. Erdniev and task constructor by L.S. Ilyushin. Students are introduced to the basic concepts of the synergetic theory of self-organisation. The interdisciplinary integration of mathematics and natural sciences is explored for students' professional training, the results of which are reflected in publications.

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