The formation of students’ telecommunicative competence through the knowledge synthesis in the study of natural sciences

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Abstract. The article is devoted to the search of the mechanisms of the synthesis of the knowledge that is new for a student in the development of his telecommunicative competence in the study of natural studies at the university. The authors interpret the concept «telecommunication» as targeted transferring, receiving, analyzing, synthesizing and assessing information through the interaction of its real and virtual carriers that can be removed in time and space. The authors define «telecommunicative competence» as the personality trait which determines readiness to specific form of professional activity and life in information society comprising the knowledge of telecommunicative technologies, forms, rules, regulations and traditions of mutual exchange of information; capacities to independent development in the sphere of telecommunicative technologies, assimilation of a great deal of information, result prediction in the solution to the problems in professional activity; the abilities related to transferring, receiving, coding, analyzing, transforming, generating information. During the research the authors identify seven mechanisms of subjective new knowledge synthesis in the following processes: professional inversion of preliminary knowledge; application of gained knowledge in practical work: diversification of professional training content; establishment of interdisciplinary connections between specialty curriculum disciplines; simulation of training and productive situations and processes: functional approach to the development of telecommunicative competence; transference of concepts, principles, regulations, theories set out in a discipline to the subject of another. The studied mechanisms of subjective new knowledge synthesis expand the set of tools that can be used by both a teacher and a student in the formation and the development of telecommunicative competence.

1. Introduction

The problem of synthesis of knowledge that is new for a student but known for science, the study of the mechanisms of the process for a long time are among the most urgent issues. Such new knowledge for a student will be determined as «subjective new knowledge» in contrast to «objective» new knowledge obtained in science originally. Relevance of the solution to the problem is also connected with the formation of subjective new knowledge which is the most significant results of any educational process. Moreover, subjective new knowledge synthesis enables the formation of new skills and abilities, and it is the basis for the development of any student’s competencies including professional ones. The quality of subjective new knowledge is expected to determine the quality of education provided.
The processes of subjective new knowledge synthesis have been studied by different authors for a long time. M.N. Shardakov, for example, considered that «synthesis as a definite and specific thinking activity provides a whole new result, some new knowledge of reality…Synthesis provides something new in relation to the synthesized material» [1]. However, it should be noted that a fairly profound analysis of the processes of subjective new knowledge synthesis and any complete list of its mechanisms do not exist in pedagogical literature. Taking into account the globality of the task and difficulties in its address in general, we moved towards some narrowing of our studies to the research of «mechanisms of subjective new knowledge synthesis in the development of University student’s telecommunicative competence».

2. Materials and methods

As some concepts and terms used in our research are not prevalent and developed, their content and scope should be refined. The concept «telecommunication» refers to the targeted transferring, receiving, analyzing, synthesizing and assessing information through the interaction of its real and virtual carriers that can be removed in time and space. The concept «telecommunicative competence» refers to the personality trait which determines readiness to specific form of professional activity and life in information society comprising the knowledge of telecommunicative technologies, forms, rules, regulations and traditions of mutual exchange of information; capacities to independent development in the sphere of telecommunicative technologies, assimilation of a great deal of information, result prediction in the solution to the problems in professional activity; the abilities related to transferring, receiving, coding, analyzing, transforming, generating information. The concept «professional knowledge inversion» refers to the «turn» of student’s education content to the future profession and, consequently, the change of the nature of preliminary knowledge to improve his level of readiness for professional activity.

The research of the mechanisms of subjective new knowledge synthesis in education will be based on existing works in the field of objective new knowledge synthesis, obtained by experimental and theoretical scientific research, first of all. V.S. Tyuchtin, for example, studying the problem of new knowledge synthesis, identified its three mechanisms: «The first of them refers to the consolidation of scientific knowledge into some total unit. The example of it is consolidation of facts, phenomena, laws from separate sections of physics course…The second mechanism of synthesis forms whole new knowledge which is generalization of present knowledge after emergence of new results. The example of it is Periodic Table of Elements by D.I. Mendeleev, synthesizing the knowledge of physics and chemistry. The third mechanism of synthesis refers to the cognitive tools, to the methods of knowledge expression and transformation» [2]. A.K. Astafiev focuses on another important mechanism of new knowledge synthesis: «Knowledge synthesis takes place within scientific concepts, principles and theories characterizing conceptual aspect of science interaction» [3].

3. Results and discussion

Based on the above and many other researches as well as long-term experience of teaching of natural sciences cycle in Bunin Yelets State University we identified seven mechanisms of subjective new knowledge synthesis in the development of student’s telecommunicative competence.

3.1. Subjective new knowledge synthesis in professional inversion of propaedeutic knowledge

Professional inversion of preliminary knowledge can be achieved by means of different methodological practices (mechanisms), for example, transferring the knowledge which is educationally or professionally general to the subject of sectoral (narrow-professional) knowledge. After transferring knowledge from one discipline to the knowledge system of another one new connections emerge in it, that process is accompanied by the change of the structure in the system of knowledge of the discipline. Consequently, the conditions for subjective new knowledge synthesis in student’s mind are created. At the same time amount of student’s system of professional knowledge expands. Propaedeutic knowledge
changes its course and character due to integration to a new system and it allows developing student’s professional competencies.

An example of subjective new knowledge synthesis in professional inversion can be the following: «Kerckhoffs’s principles» for electrical circuits studied during the general physics course refer to «physics» knowledge on electrical phenomena. Transferring this knowledge to the subject of another specific discipline, such as electronics, results in its inversion. The system of sectoral narrow-professional knowledge is centered on physics knowledge like on a certain core. Formation of new connections between «physics» and «professional» knowledge can lead to the subjective new knowledge synthesis. It should be noted that the very essence of propaedeutic knowledge (Kerckhoffs’s principles in the example above) remains the same. It is «physics knowledge» but its integration into the new system and formation of new connections change its course and character.

The formation of a new system, which includes physics and sectoral knowledge, results in so called «systemic knowledge» being new for a student. Propaedeutic knowledge as a consequence of inversion increasingly focuses on the profession depending on what profession knowledge system it is included. For example, the knowledge of Kerckhoffs’s principles remaining essentially «physics», increasingly focuses on the physics teacher profession if it is included into the system of his professional knowledge. The knowledge of Kerckhoffs’s principles increasingly focuses on the computer white-collar operator profession if it is included into the system of his sectoral knowledge and so forth. In this processes on the base of «physics core» subjective new knowledge synthesis occurs, the content of knowledge being different for different professions because it focuses on various types of professional activity.

It is significant that the knowledge of Kerckhoffs’s principles as well as physical, chemical, biological and other laws, which are studied in different disciplines, is actually the result of high-level numerical experience evidence consolidation. It leads to their complicated direct usage for the solution to the particular, narrow-professional tasks in the production conditions. Therefore only after inversion and further subjective new professional knowledge synthesis knowledge integration becomes suitable for practical application.

There is another example: the knowledge of main principles of telecommunicative network design is a part of general professional training for a great number of specialties. Transferring this knowledge to the subject of another specific discipline, such as «telecommunicative network architecture of a sectoral enterprise» results in professional inversion of preliminary knowledge, provides the conditions for further subjective new knowledge synthesis, the development of student’s telecommunicative competence. It should be noted that the content (knowledge systems, skills, abilities) and the character (knowledge depth and amount, the quality of skills, the level of abilities) of telecommunicative competences for different industrial branches will be different. Subjective new knowledge in such various forms will be used by a specialist in his practical activity.

### 3.2. Subjective new knowledge synthesis in practical work

During professional training at the University much time and attention is devoted to students’ practical work. The knowledge that he has gained earlier at the theoretical level enables such activity. This knowledge in relation to practical work occurs in various forms: the goal of the work, its general idea, analysis of student’s personal capacities and work conditions, organizational plan, content of ongoing activities, result assessment. Meanwhile personal experience acquired earlier is a criterion that provides selecting necessary information for the work and removing unnecessary, separating essential information from background data.

Successful development of student’s telecommunicative competence is difficult to imagine without considerable experience his practical work in the field of telecommunicative technologies and corresponding techniques. Without personal experience of training professional and afterwards professional work a future specialist will imagine studied production process, which is held in a particular enterprise, as a combination of separated elements or operation phases. Such way of professional knowledge acquisition is inefficient, inadequately representing actual practice, very labour-intensive because a student has to learn and analyze a great deal of initial information the substantial
part of which will be of little use and will not be applied in the future. The analysis of future specialist’s own experience gives him an opportunity to see this or that process continued in time and located in space, unified in all its interconnections and expressions. It provides necessary conditions for his efficient work in an enterprise.

3.3. Subjective new knowledge synthesis in diversification of professional training content
In new conditions of universities’ activities, their interaction with environment current realities of particular production or a national economy sector should be reflected in future specialists’ professional training content. In this case the conditions of his future work must determine the structure, content and nature of telecommunicative competence, its long-term development vector. There is an increasing demand of society, a worker himself and his employer in the educational system which is able to provide training of highly-qualified competitive mobile specialists in a modern labour market nowadays.

Particularly, labour market forms high demand for the workers who, apart from the content of the specialty curriculum, acquire extra knowledge, abilities, skills, raise the level and the quality of professional competencies in relation to the regulatory requirements of FGOST. Such situation is due to the fact that, for example, a specialist in telecommunicative network often has to perform the work which is not directly related to his official duties but which he can perform better than other staff members as he is good at computers and telecommunicative technologies. Developing the problem of diversification of professional training content, E.V.Andropova, Y.I. Brezgin, V.E. Medvedev concluded that «this process of expanded operations of vocational education institutions to the new for them spheres is realized through the integration of education, science and production… » [4, p. 145].

3.4. Subjective new knowledge synthesis in establishment of interdisciplinary connections between specialty curriculum disciplines
The formation of new knowledge systems takes place during establishment of interdisciplinary connections between specialty curriculum disciplines and, consequently, the conditions for subjective new knowledge synthesis are created. In this case the connections between disciplines will be considered as one of the form of their integration enabling to smooth out particularly disadvantages of subject-based training that appeared at the time due to the differentiation of sciences. Subjective new interdisciplinary knowledge synthesis brings us closer to the expected ideal – the system of «holistic» professional training and rejection of still taking place practice of «specialists’ training in parts», for example, in physics, mathematics, information technologies and so on.

The result of establishment of interdisciplinary connections between specialty curriculum disciplines will be subjective new knowledge which cannot be formed in a student if these disciplines are not studied according to their interconnections. For instance, the study of modern means of telecommunicative technologies is impossible without involving knowledge from different branches of physics, mathematics, electronics and so on. As a result of this process students broaden their minds, improve the knowledge of studied disciplines. Establishment of interdisciplinary connections can be regarded as one of the specific mechanisms of subjective new knowledge synthesis.

3.5. Subjective new knowledge synthesis in simulation of training and productive situations and processes
A lot of both scientific knowledge and study methods are based on the concept of simulation. These methods are applied for obtaining objective new and subjective new knowledge. Subjective new knowledge synthesis occurs during natural and mental simulation. On its basis we create an object model of our study, determine essential interconnections of its components in time and space, analyze their interaction with environment. The study of a model gives us extra information about a researchable object.

While studying a model an opportunity to predict a real object dynamics arises. Model construction is said to be some form of information coding about a researchable object. Analyzing model dynamics, we try to represent this information in visualized format and use for access to new knowledge. The
application of the simulation method is especially efficient in a study of complicated technological processes and technical systems like telecommunicative ones. Not only subject knowledge gains in this case but the abilities of consolidated operation ways develop [5].

3.6. Subjective new knowledge synthesis in functional approach to the development of student’s telecommunicative competence

The most important element of formation and development of telecommunicative competence is the knowledge of job functions (official duties) that a future specialist should be prepared to perform. Subjective new knowledge synthesis, the formation of new abilities in functional approach to the development of student’s telecommunicative competence can be considered as a basis for his readiness to perform his official duties at the future workplace [6].

The type of specialist’s key activity influences the content of his competencies and, consequently, their development significantly. E.N. Gusinsky and Y.I. Turchaninova think that “the key activity is a systemically building factor of personality development” [7, p. 121]. Subjective new knowledge that is synthesized in functional approach to the formation of professional training content is one of the foundations of student’s telecommunicative competence development.

3.7. Subjective new knowledge synthesis in interdiction of new concepts, principles, theories, regulations or methods

Transference of a concept, a principle, a pattern, a method or a theory from one training discipline to another creates conditions for access to subjective new knowledge. A concept, a principle, a regulation, a method, a theory are knowledge systems which can be identified as the content of training discipline in one case and as a basis for formation of new connections between one training subject and another, as a tool for subjective new knowledge synthesis. For example, Ohm’s Law is the content of «Physics» course, from one side, and awareness of this Law enables to establish connections between the content of physics and chemistry, from another side, because it provides a chemistry teacher an opportunity to explain change periodicity of chemical elements properties and ensure conditions for student’s subjective new knowledge synthesis.

New concepts, principles, regulations, theories and so on perform as “a catalyst” for subject knowledge synthesis in the discipline in which they have been transferred. For instance, studying conceptual framework of modern quantum physics provides conditions for new subject knowledge synthesis not only in the course of physics but in the course of electronics, television and radio technologies, computer architecture and in other training disciplines. It is significant that transferring this or that concept, principle, regulation, theory or methods from one discipline to another is not enough for subjective new knowledge obtaining, the formation of a new knowledge system as a complicated unit that cannot be restricted only by the content of one of its element or their sum [8].

4. Conclusion

The study found seven mechanisms of subjective new knowledge synthesis in the following processes: functional approach to the development of telecommunicative competence; transference of concepts, principles, regulations, theories set out in a discipline to the subject of another. The mechanisms of subjective new knowledge synthesis studied above expand the set of tools that can be used by both a teacher and a student in the formation and the development of telecommunicative competence.

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