Formation of professional competences in students of transport universities to meet modern requirements

Lyudmila Borodina*, Ekaterina Klimenko, and Anna Rychenkova
Admiral Ushakov Maritime State University, 93 Lenin Ave., Novorossiysk, 353924, Russian Federation

Abstract. The article discusses the stages of the formation of professional competencies in the process of training future engineers of the Navy. An analysis of the concept of competence in the interpretation of modern scientists is carried out. The features of the formation of professional competence are analyzed, considering the specifics of a general technical academic discipline, and the integral role of skills and abilities as objects traditional for pedagogy is shown. It is shown that the competencies that a university graduate must master can be divided into two classes: professional (subject-specialized) and general cultural (universal), not directly related to the solution of professional problems, but related to the success of the professional activity. As a result of the analysis of the task of designing the content of subject competencies, the fundamental functional structure of the process of forming the professional competence of a general technical academic discipline is presented. The problem of the relationship between sensory (empirical) and rational (theoretical) knowledge is revealed in the aspect of applying theoretical knowledge in the practical activities of a transport specialist.

1 Introduction

Modern world makes graduates confront with new challenges thrown down by globalization taking place in science, education, and technology. This is especially true for transport employees, as significant changes in the international labor market seriously modify the existing labor relations. A new type of international employee is being created, who has to adapt fast to the changing conditions of modern production, move freely, be flexible enough in contacts with other groups of employees, be able to work in a team, communicate effectively.

This type of workers fosters a new cohort of professionals employed in globally oriented production, which continues to grow and improve. The level of professional education is aligned with the rate of graduate employability, their social self-awareness, the rate of labor competitiveness, and indicators of youth unemployment. Today, our graduates enter the modern labor market that prominently features variability, flexibility, and high innovative character.

Today, the value of society and the paradigm of education is the ability of graduates to solve new, unfamiliar tasks by their own efforts, and therefore learning outcomes are measured by the experience of solving such tasks. Along with general literacy, the main thing is the ability of graduates to act and make effective decisions in dilemmas, the ability to think critically, to act effectively in a competitive environment. The priority is not so much the acquisition of knowledge but the management of knowledge, information for solving specific social and professional tasks in which it can be required. After all, this becomes one of the most meaningful predictable outcomes of education.

2 Problem Statement

Modern education is mostly aimed at the development of basic competences to facilitate the acquisition of knowledge independently, if need be, rather than the transfer of knowledge that often gets outdated. Mastering the basic competences is considered an indicator of the social and psychological maturity of an individual. The Federal State Educational Standard of Higher Professional Education of the third generation (FSES HPE) approves the need to design the content of domain expertise of students and review the content of subjects from these perspectives [1].

In accordance with these requirements, state educational standards for training future marine engineers were developed, which established the key types of future professional activities of graduates: design, organizational and managerial, production and technological, experimental research. In solving the tasks set in the system of higher professional engineering education, general science and technology disciplines become important to frame engineering knowledge for
future employees, the ability for engineering innovations and their improvements [3].

Such disciplines include engineering and computer graphics. Recently, the scope of tasks solved by the methods of descriptive geometry and engineering graphics has significantly expanded to embrace new fields. The attempts to produce professionals with graphic knowledge and experience to apply it in educational activities, who are committed to continue this experience in future professional activity, professionals with well-tailored engineering mentality and technical abilities, predetermined by the use of modern information technologies in the education system, are not fully achieved.

3 Results and Discussion

The scientific basis for highlighting the parameters to measure the level of mastery as an index of achievement was made up of numerous scientific past and present publications that have made efforts to find a way to display learning objectives diagnostically and control the level of their achievement. The scientists have developed a very effective conception that explains the nature of human learning and activity. It asserts that any activity is performed by a person solely based on the previously acquired information. The better and more solid it is, the more effective the activity. Identification of performance indicator that the developed professional competence should correspond to as a kind of holistic formation, gives an opportunity to proceed to solving the very process of developing professional competence.

It is known that learning any activity is impossible unless there is some knowledge about an object, a subject and methods of doing activity. Therefore, developing a learner’s competence should start with acquiring knowledge that, once perceived as current reality, as well as signs showing it in the form of concepts, statements, formulas, drawings, etc., enables learners to relate these signs to concrete objects, show these signs in a language corresponding to their experience, and thus acquire new knowledge, in the domains easy-to understand, yet few. With no memorization, there would be no understanding acting as an awareness of links, albeit elementary and superficial, between the objects constituting the world around. Such mastery is also followed by each directed action. It is impossible to deliberately implement it without being aware of its likelihood, the way it can be implemented.

Hence, the first stage in developing professional competence is mastering general engineering domain-specific knowledge, which forms the backbone of the competence to be examined. A natural impact on learners, which ensures successful completion of this stage, is communication of learning material, aimed at transferring or opening up a fragment of their learning activity to learners, thus attracting them to this activity.

But you can know something and not to be able to put it to practice. Thus, to learn some activity, you have to learn how to actually perform it, and to master a way of doing an activity, it should be repeated over and over. This is necessary not only to keep it in memory, if it is difficult, but also in order to gain expertise of how to implement it to do it quickly and efficiently. This is how a way of doing something, familiar to society and known to students, actually becomes a skill or ability. They are the acquired ways of doing things familiar to society and communicated to learners. In order to ensure this type of learning, the teacher creates conditions for learners to gain the experience of reproductive activity. In terms of shaping professional competence, this reproductive experience will be complete as long as operational skills mastered by the learners include all the individual actions that can be created within the studied professional competence.

Thus, the second stage in developing professional competence is developing operational skills that ensure solutions of core generic (typical) tasks of a general engineering academic discipline and the mastery of all actions that can be performed within the considered professional competence. The same teaching impact on learners, which makes sure that this stage is successfully completed, is various options for task situations constantly presented to learners, corresponding to all types of generic tasks studied.

However, even the acquisition of general engineering domain-specific knowledge, nor the development of operational skills and abilities can ensure the implementation of the developed professional competence in those conditions that are not known to the teacher or can be shown due to the violated didactic principle of accessible learning content.

The third stage in developing professional competence is developing student’s ability to come up with ways for solving subjectively new challenges. This ability ensures that the competence developed can be applied in any conditions, and, therefore, in the profession that the student is currently mastering. The third stage features obligatory student’s self-study and teacher’s functions limited by the only function – the function of transferring new learning tasks to the student (learning tasks that the student does not know how to solve) [6,7].

The difference in the way skills and abilities are being developed, which involves recreating the same standard of activity, the process of forming heuristic features requires activity each time in new circumstances and periods. Meanwhile, prompting the learner how to solve the task at the third stage of competence development is a return to the second stage. For this reason, heuristic activities do not have their own precisely prescribed systems of action. Stories about heuristic activity, about the conditions conducive to its implementation, can help to acquire the experience of heuristic activity, but cannot promote its development as such. Therefore, the only way to master the features of heuristic activity and the experience to apply them is to solve tasks that are new to the student individually. “Unlike reproductive activity, the experience of productive activity can only be learned by solving subjectively new problems. To handle this way of learning, the teacher shall construct and present easy-to-understand tasks to the student, divide challenging tasks
into subtasks, monitor the progress of solving them and guide him/her only by presenting other new problems and sub-problems” [4,8].

The final third stage in developing professional competence is student’s ability forged to develop ways to solve subjectively new problems that arise or may arise within this competence. An adequate learning impact on the student, which ensures successful completion of this stage, is new learning objectives set out for the student.

In solving the problem of determining the key characteristics of professional competence development, this conclusion could be final, if it were not for the components of reproductive and productive experiences in the structure of competence shown in Fig. 1. They are reasonably necessary from the standpoint of an accepted interpretation of the concept of competence as “the ability to act successfully relying on skills, knowledge and practical experience in performing a task, solving a professional problem” [1]. Knowledge, abilities, skills (KAS) are traditional pedagogical objects considered as components of academic programme for the teacher, and for students – as learning outcomes.

In the traditional interpretation of the concept of competence, “practical experience” is considered as a component of competence along with “knowledge” and “skills”. This raises a number of questions, primarily concerning the interpretation of the concepts of experience and practical experience. The findings suggest that it is not correct to put “practical experience”, in the officially accepted interpretation of the concept of competence, on a par with “knowledge” and “skills”, as “practical experience” is “a set of knowledge, skills and abilities learned in practice”. The incorrectness provides the interpretations of the concept of experience that is given by the explanatory dictionaries of the Russian language by S.I. Ozhegov and S.A. Kuznetsov as 1) a totality of knowledge, skills and abilities learned in practice; 2) reflection of the objective world in human mind, obtained through sensory perception based on the practice of changing the world, sensory experience; 3) reproduction of any phenomenon in artificially created conditions to research it, the same as an experiment; 4) an attempt to implement something, a trial.

A.M. Novikov in [2] respectively defines the first two Ozhegov’s interpretations as “experience in the psychological and pedagogical sense (experiment (ps.-p.)” and “experience in the philosophical sense (experiment (philos.))”. He also introduces the structure of experience (ps.-p.) in Fig. 1.

A.M. Novikov defines skills as “abilities mastered by a person to perform actions” and considers them as “compound structural accumulations, including sensual, intellectual, volitional, creative, emotional personal qualities, ensuring the achievement of the goal in the changing conditions it is being pursued.” “Skill is the highest human quality that, once developed, signifies the accomplishment of the ultimate goal of the pedagogical process, its completion” [2].

Besides, A.M. Novikov believes that the extended definition of skill he gave was introduced in 1973 by the domestic psychologist and teacher E.A. Mileryan. Skills were perceived not in a narrow practical sense, but as “complex structural accumulations, including sensual, intellectual, volitional, creative, emotional qualities of a person, ensuring the achievement of the goal of an activity in the changing conditions it is being implemented.” Unfortunately, this theory of skill development turned out to be unclaimed. In English, there is no analogue to the Russian concept of skill. When educational society faced the problem of activity-oriented education, the term “competence” began to be used in the Anglo-American educational environment.

According to E.A. Mileryan “the development of skills always embraces personal sensory, intellectual, motivational, volitional and emotional spheres, invariably contributing, with the proper methods of guidance applied, to those personal qualities that are applied in this type of professional activity.” A.M. Novikov, comparing the concept of competence with the concept of skill in Mileryan’s interpretation comes to the conclusion that “in fact, competences are synonymous to skills”. Except for one fundamental point – the competences have expanded to include a motivational component. Some authors say that competences differ from skills in a way they have motivation.” Indeed, all the structural components of the personality: knowledge, worldview, interests, thinking, etc. make way, as it were, to the “inner plane”, are located inside human consciousness. The only external exhibition of human consciousness is activity, and the ability to perform successfully is skill.

A.M. Novikov is supported by several authors. Thus, M.E. Bershadsky says that “the concept of competence does not contain any fundamentally new components that are not included in the scope of the concept of skill, which implies that all debates and studies to investigate

![Fig. 1. Novikov’s structure of experience (ps.-p.) [2].](image-url)
competency and competence are artificial and are merely geared to “hide old problems under new clothes” [2].

Accepting the Novikov’s position about the similarity of the concepts of competence and skill, let us consider the traditional interpretation of the concept of competence as an attempt to separate rational (academic) and sensual (empirical) knowledge and skills and emphasize the significance of the latter.

The subjective personal knowledge and skills are known to include both rational (academic) knowledge and skills, and sensual (implicit, empirical, figurative) knowledge and skills. The latter may not be conveyed by words (concepts) and are acquired not in the process of mastering someone else’s subjective social experience (experience as a body of knowledge and skills), but in the process of one’s own experience (experience as an attempt to do something, as an experiment). Reasonable (academic) knowledge is social knowledge. Since social knowledge has a subject structure, it is commonly represented in the form of concepts, laws, principles, etc. What is more, every person has figurative knowledge (it is otherwise called direct, sensual knowledge) at the level of sensations, perceptions, images. Didactics, through visualization of education, certainly paid attention to this type of knowledge. However, sensual knowledge is very important for successful activity, not only in the sense of visibility. However, the issues of student’s sensory knowledge have moved away from the mainstream of the learning process. Therefore, the issue of connecting sensual and rational (theoretical) knowledge, which is extremely important in terms of theoretical knowledge to be put to practice, has long remained and, unfortunately, remains in the shadows.

![Fig. 2. Principal functional structure of professional competence development.](https://doi.org/10.1051/shsconf/202316400106)

4 Conclusion

At present, personal professional qualities are increasingly important. Yet, second and third generation
educational standards, professional standards, or graduate diagnostic system almost contain no requirements thereto. It is not just qualification required that is too often attributed to the ability to perform certain practical operations, but competency that is seen as some mixture of skills inherent in each person that combines qualification in its strict meaning, social behavior, the ability to work in a team, use one’s initiative, social behavior, the ability to work in a team, use one’s initiative, and the ability to work in a team, use one’s initiative, and the ability to work in a team, use one’s initiative.

Accordingly, the competences that a university graduate must master are divided into two classes in the FSE: professional (subject-specific) and soft (universal), related to successful professional activity rather than to solving professional tasks.

A competency-based approach that can just as well be called a “skill approach” is progressive precisely because it fosters a transition to modern educational paradigms – from “knowledge” to “activity”. This transition is impossible without defining and improving the relationship between sensual and rational, theoretical knowledge that underlies the level of achievement. Then the traditional interpretation of the concept of professional competence as “the ability to act successfully relying on skills, knowledge and practical experience when performing professional tasks and searching for professional solutions” [1,2] can be represented as follows: professional competence is the ability to successfully act relying on a combination of rational (academic) and sensual (empirical, figurative) knowledge and skills in solving professional tasks [6, 7].

This definition does not contradict either the official interpretation of the concept of competence, or the extended interpretation of the concept of skill, or the traditional interpretations of the concept of experience. Given this interpretation, the concept of competence can be represented in the following form (Fig. 2).

Today, higher education is geared to implement the competency-based approach rendered indispensable by modern socio-economic, political, spiritual, and moral transformations in society. In the Soviet Union, education was entirely considered professional, while personal development was seen as a by-product. At present, to ensure graduate employability and adaptation in the workplace, including in the transport industry, it is desirable to primarily develop “soft” skills that can be applied in a variety of settings and environments.

The content of education agrees with a graduate competency-based model and should be designed in such a way as to ensure the development of required soft and professional competences. Today, science and technology education is at the heart of major challenges related to the effective entry of national education into the common European space. Professional education is particularly challenged to train on-fire qualified employees capable of doing world-class jobs, ready for social and professional mobility in a constantly changing social environment [8].

References

5. L.N. Borodina, E.S. Klimenko, A.Yu. Rychenkova The use of multimedia teaching aids during lectures on descriptive geometry and engineering graphics at a maritime university, Bulletin of Admiral Ushakov State Maritime University 1(38), 104–120 (2022)