Organization of research activities of first-year students in a maritime university

S I Pankina*, E H Amineva, M N Lyutikova, and E N Shushuka

Admiral Ushakov Maritime State University, 93 Lenin Ave., Novorossiysk, 353924, Russian Federation

Abstract. At present, with the widespread introduction of new information and innovative technologies that require an increase in the volume of assimilated and processed information, it becomes necessary to train specialists able to demonstrate creative activity, innovation in various fields of professional activities, and to quickly adapt to changing conditions. The new requirements imposed on university graduates are formed through the active participation of students in research activities, which is noted in the new federal state educational standard of higher education (FSES HE). This paper discusses the peculiarities of organizing research activities of cadets at the initial stage (1-2 years of study) of training at a maritime university. The novelty of the chosen topic includes the development and description of methodological recommendations for organizing the research activities of cadets of a maritime university when studying the disciplines of the basic cycle. The paper draws special attention to the rational choice of methods, forms, techniques of research activities that allow organizing active scientific work within the framework of a given university.

1 Introduction

The creation of an innovative educational environment for a maritime university that provides high-quality professional training for cadets is one of the priority issues and requirements in accordance with the FSES HE. One of the possible ways to solve the professional development of highly qualified specialists in the marine industry is to form skills and abilities based on the organization of their research activities at the university. The focus on improving approaches to the educational process and the quality of professional training of specialists of the marine industry is inextricably linked with improving the safety of the ship and crew, and the economic efficiency of the transport fleet.

The state educational standard is the main set of regulatory, organizational documents and methodological measures that determine the content, structure and main areas of professional training of cadets of a maritime university in the areas of study, the professional activities of which include research and project-based activities in the field of water transport operation.

According to the FSES HE, research activities at the Admiral Ushakov Maritime State University (MSU) in marine specialties include the following areas:

- Participation in basic and applied research in the field of water transport, shipping, transport and technological equipment;
- Analysis of the state and dynamics of quality indicators of objects of professional activity using the necessary research methods and means;
- Development of plans, programs and methods to study the objects of professional activity;
- Search and analysis of information on research objects;
- Technical, organizational support and implementation of research.

Thus, the involvement of cadets in research activities in various forms already in the first years of study, the degree of their activity and motivation for research work allows mastering the methods of search and systematization of information on the specified problem, forming an overview material and a bibliographic list according to GOST, highlighting the relevance of the problem and finding solutions.

Thus, the reliance of the study is caused by the significance of familiarizing the cadets of the maritime university at the initial stage (1-2 years of study) with the elements of research activity, study approaches to the practice of using scientific methods in the student environment and reveals several contradictions between the following:

- need to form the creative personality of a future navigation engineer and traditional forms of training

* Corresponding author: sipankina@mail.ru

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aimed at forming only professional knowledge and skills;
• training a highly qualified specialist ready for continuous professional training, self-improvement and use of traditional training methods;
• use of research elements within the framework of the university and insufficient development of methodological recommendations for students;
• need to organize the research work of cadets at the university and lack of teacher training for such activities.

### 2 Materials and Methods

Scientific and technological progress, rapid development of information opportunities, intellectualization of maritime transport reflect trends in the need for specialists in the maritime industry trained at a new level and possessing knowledge in the elements of research activities.

The training of graduates who know the main methods of research should be carried out throughout the entire period of study at the university, and its main elements should be laid at the first stages of training in the study of basic engineering and technical disciplines.

Despite the large number of works on this topic [1-5], their analysis and many years of experience at Admiral Ushakov Maritime State University show that the tasks of introducing cadets to research activities have not been fully solved and without understanding the theoretical and substantive foundations.

The purpose of this study is to develop and describe methodological recommendations for organizing the research activities of cadets of a maritime university in the study of basic disciplines.

The object of the study is the research activities of cadets of a maritime university.

The subject of the study is the formation of elements of research activities in the process of professional training at a maritime university.

The objectives of the study are as follows:
• to analyze the state of development of the research problem in theory and practice;
• to clarify and characterize the conceptual apparatus in the field of study;
• to study the standards and basic regulatory documents for the professional training of cadets of the maritime university;
• to determine the methodological features of research activities of cadets in a maritime university;
• to study the issue of organizing research activities at Admiral Ushakov Maritime State University.

Research activity is a link between all elements (goals, methods, forms, means) of professional training of cadets. The organization and planning of this activity is the main component of training.

In the scientific literature [6-12], the concepts of “educational and research activities of students” (ERAS) and “research activities of students” (RAS) are often correlated.

The main difference between these types of activities is the acquisition of subjectively new knowledge obtained as a result of educational and research activities and fundamentally new knowledge on the identification of objectively existing patterns of phenomena and processes as a result of research activity.

Educational and research activities are organized by the teacher through the study of basic disciplines (mathematics, physics, computer science, basics of navigation, etc.) on the basis of indirect management, when a cadet has to fulfill a number of research tasks, and the teacher gives guidelines by indicating the necessary actions.

In his work, A.V. Leontovich says that the main goal of research activity is to acquire students’ research skills, research type of thinking and intensify their position in acquiring new knowledge [6].

Let us consider several directions for defining the concept of “research activity”.

Klimova I.E. defines research activity as interaction (collective and individual) with the help of objective and systematic knowledge of reality, contributing to the enrichment and development of culture and civilization [7].

As A.V. Moskvina notes, research work is an independent and creative assimilation, the use of knowledge and skills based on solving scientific problems that lead to new significant results [8].

Research activity as a component of creative activity that creates the basis for obtaining a new result is determined in the work by Romanov P.Yu., et al. [9]. At the same time, creative activity is characterized as an activity, which result is a product with novelty, originality and significance.

We understand the research activities of cadets as work that represents a combination of methods and means of independently solving scientific and engineering and technical problems, the result of which is the receipt of new information or new knowledge.

The research supervisor or coordinator should give the first guidelines for important professional areas of activity in order to allow the cadet to decide on the topic and throughout all stages of work to help correctly build and formalize his activities.

The acquaintance of students with the course of organizing research is based on the following main stages:
• selection, justification and relevance of the topic;
• setting and formulating the goals and objectives of research; determination of the object and subject of study, study of properties and characteristics;
• selection of methods (techniques) of research, description of the main areas of work;
• description and experimental verification of study results; registration of the obtained results;
• discussion of the obtained results and their further application.

Based on the presented main stages of research activity, the following methods are used:
• problematic (analogy, comparison, historical approach, information analysis, hypothesis), allowing
the cadet to informationally study reference literature and documentation in order to select and cover the study problem;
• analytical (observation, analysis, synthesis, induction, deduction) systematizing quantitative and qualitative indicators, characteristics, signs of studied processes and phenomena;
• search (system analysis, modeling, operations study, logical approach, design approach, system and technical) to determine ways to solve the research problem;
• experimental (experiment, measurements, functional analysis, generalization, discussion) confirming or refuting the results of research;
• prognostic (comprehensive analysis, abstraction, concretization, rationalization, prognostication), which make it possible to verify the obtained results and describe their possible implementation.

According to the FSES HE, when developing a program of research activities within the framework of the university, cadets should take the following measures:
• study special and scientific-technical literature, modern developments in domestic and foreign fields of knowledge;
• participation in research and technical development;
• collection, processing, analysis and systematization of scientific and technical information;
• participation in industrial tests of prototypes of designed products;
• reporting on sections and topics;
• presentation at scientific conferences.

Table 1. Structural components of the research activities of cadets and their content.

<table>
<thead>
<tr>
<th>Structural components</th>
<th>Content of the main components of research activities</th>
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<tbody>
<tr>
<td>Need</td>
<td>Realization of intellectual potential, personal fulfillment, increase of the level of creativity and logical thinking.</td>
</tr>
<tr>
<td>Reason</td>
<td>Search, study and resolution of professional problems, development of the level of self-awareness, self-organization and self-study.</td>
</tr>
<tr>
<td>Subject</td>
<td>Basic disciplines and research activities within the framework of these disciplines.</td>
</tr>
<tr>
<td>Purpose</td>
<td>Acquisition of skills of a researcher able to use modern tools of scientific methods and technologies for research activities.</td>
</tr>
<tr>
<td>Action</td>
<td>Study and analysis of research results, search for individual creative solutions to research problems.</td>
</tr>
<tr>
<td>Operations</td>
<td>Development of methods and techniques to solve professional problems, use of new computer technologies.</td>
</tr>
<tr>
<td>Result</td>
<td>Training a highly qualified specialist capable of continuous professional growth, self-development and self-improvement, ready to independently carry out research using modern methods of science.</td>
</tr>
</tbody>
</table>

To obtain a comparative analysis on the organization of research work of cadets the teachers of basic disciplines set and solved the following tasks:
• description and selection of methods in the main areas of research activities of students;
• organization of cadets’ work in various forms and activities;
• statistics on the results of cadets participating in various forms of research activities.

The process of professional training of cadets at a maritime university will be the most effective if those who participate in all stages of training will be involved in different forms of educational and research activities.

Since the purpose of the maritime university is the professional training of cadets, the training process is focused on the development of the personality of a specialist in the maritime industry and his professional qualities. The Qualification Committee welcomes the use of elements of research activities in the final qualification paper and the acquisition of objectively new knowledge. Cadets that write such final qualification papers are advised to continue their postgraduate studies or work in research laboratories.

The activity of a teacher or supervisor of the research activity is as follows:
• to indicate the compliance of research work with the set goals and objectives of the study;
• to identify possible contradictions in the work;
• to indicate the direction of activity of a cadet according to the hypotheses put forward;
• to assess the scientific novelty of the developed topic;
• to recommend the form of presentation of the research work [12].

The analysis of the cadets’ thesis shows their inability to present the final qualification work as scientific relying on the knowledge gained throughout the entire study period (5.5 years).

Table 1 highlights the main components of research in the professional training of cadets of marine specialties.

The analysis of works [9–12] during the research activity of students at the university made it possible to see various aspects and approaches on the studied topic.

Our interest in this topic is caused by the lack of major research on the problem of personal professional development of students in the context of multifaceted research and creative work. It is correct that the research work of students in higher educational institutions has
enormous potential, often unrealized in the educational process.

Considering the analysis of works on the studied problem, we distinguish the following main components for activating the research activity of cadets at the maritime university:

• understanding the importance of the research activity at the first (basic) stage of training by the students themselves;
• level of research activity of teachers of basic disciplines and involvement of students in research work.

3 Results and Discussion

The research activities of cadets at the university are a set of measures aimed at mastering the methods, techniques and skills of research, analysis and systematization, abilities for scientific creativity, intensification of initiative and independence. Let us highlight and describe in Table 2 the main forms of research activities of cadets in the framework of training at Admiral Ushakov Maritime State University. Such types of activities include a report at a seminar, an abstract, course work, a scientific report at a conference, a scientific article in a student journal, a scientific article in international publications, participation in competitions [13].

Let us note the research activities conducted within the framework of the university with cadets of 1–2 years of study.

It should be noted that the research activities of cadets are divided into activities within the framework of the educational process and activities organized during extracurricular hours [14].

<table>
<thead>
<tr>
<th>Research activities during studies</th>
<th>Research activities during extracurricular hours</th>
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<tbody>
<tr>
<td>• problematic lecture;</td>
<td>• student scientific associations (unions, societies, etc.);</td>
</tr>
<tr>
<td>• innovative forms of practical support;</td>
<td>• scientific and methodological counseling of cadets;</td>
</tr>
<tr>
<td>• interactive laboratory sessions;</td>
<td>• abstract competition;</td>
</tr>
<tr>
<td>• thematic workshops;</td>
<td>• Olympiads in individual disciplines;</td>
</tr>
<tr>
<td>• information technology;</td>
<td>• faculty, university, all-Russian and inter-university conferences;</td>
</tr>
<tr>
<td>• solution of non-standard research tasks;</td>
<td>• articles in collections of scientific student papers;</td>
</tr>
<tr>
<td>• term papers;</td>
<td>• participation in faculty research;</td>
</tr>
<tr>
<td>• imitation games;</td>
<td>• participation in the work of research laboratories;</td>
</tr>
<tr>
<td>• work in project teams.</td>
<td>• competition of research projects;</td>
</tr>
<tr>
<td></td>
<td>• All-Russian, regional competitions of students’ research works.</td>
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</tbody>
</table>

The results of research activities are discussed at meetings of student research societies, roundtables, conferences with the participation of invited specialists, are taken into the defense of final qualification works [1, 2]. The research works of students are published in scientific publications, in particular, in the annual student collection The Young Generation in Science, the quarterly collection of scientific articles Bulletin of Admiral Ushakov Maritime State University, in collaboration with teachers in the journal Operation of Maritime Transport [15, 16]. Besides, the research works of cadets is presented at city, regional, Russian and international competitions and conferences:

• Atmosphere,
• Interregional student Olympiad Krasnodar-20--,
• New Generation in Science,
• Together against corruption, and so on.

There are several student research societies at Admiral Ushakov Maritime State University, within the framework of which cadets are engaged in research and project-based activities (Table 3).

The goal of student research societies was the need to:

• create new research developments in the field of transport terminals and their connections with various modes of transport;
• study promising technologies in the field of business process automation;
• solve urgent problems in collaboration with various transport and IT companies.

Admiral Ushakov Maritime State University has a unique scientific facility – an open-type low-speed wind tunnel, which is part of the aerohydrodynamic laboratory. The main areas of research and development activities of the laboratory include the following:

• mathematical modeling of dynamics of marine moving objects in normal and heavy ice conditions;
• 3D modeling and prototyping;
• physical and numerical modeling of various objects and their parts;
• high-performance computing.

Many research activities carried out at Admiral Ushakov Maritime State University, including works by the teachers of basic disciplines, can be found on the university website [14]. Creative and research work developed within educational or scientific projects motivates and encourages students to continue their research as graduate students. The best works of cadets are awarded with diplomas and certificates.
Sociological surveys (in the form of questionnaires) of teachers of basic disciplines and cadets of the second and fifth years of study were carried out to increase and improve work in this area.

Table 3. Student research societies at Admiral Ushakov Maritime State University.

<table>
<thead>
<tr>
<th>Marine Owls</th>
<th>Navigators</th>
<th>TETRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Applications of artificial intelligence in the operation of water transport and ship navigation.</td>
<td>1. Theoretical aspects of E-navigation electronic bill of lading.</td>
<td>1. Development, design, production and implementation of radio electronic warning means for sea transport facilities (seaports), as well as municipal services of the city.</td>
</tr>
<tr>
<td>2. Development of the route structure algorithm for the narrow fairway.</td>
<td>2. Simulation of flight dynamics of unmanned aerial vehicles in Sim In Tech Dynamic Simulation</td>
<td>2. IT technologies. Production of software products for the university, sea transport facilities (seaports), as well as municipal services of the city and large maritime commercial enterprises.</td>
</tr>
<tr>
<td>3. Determination of the location of the vessel based on fuzzy logic under conditions of lack of accurate certainty.</td>
<td>3. Unmanned vessel with a decision support system based on augmented reality.</td>
<td>3. Integration of unmanned aerial vehicles based on swarm intelligence into objects of marine technosphere to solve a set of problems.</td>
</tr>
</tbody>
</table>

The survey of teachers revealed that on average 5% of first-year students are familiar with the features of research activities. A fairly large percentage of cadets are not familiar with various forms of research activities at the university, and only 7% expressed a desire to participate in various research activities. The answers demonstrated an interest in the research activities of teachers themselves (87%). The university teachers expressed the desire to create manuals for cadets of 1-2 years of study, which allow getting acquainted with the main stages and methods of research activities.

The survey of the second-year cadets revealed an interest in the following forms of research activity:
- participation in scientific conferences – 32%;
- writing scientific articles – 17%.

The reasons for the small number of cadets involved in research work in the 1–2 years of study include weak motivation and understanding of the need for such work; lack of research skills; insufficient organization of work on the part of the teacher or supervisor.

The cadets (49%) noted the need for research activities, which also affects the education and research. Students proposed the organization of research activities in the form of research societies and virtual laboratories in which it would be possible to communicate and share research results using information technologies.

Table 4. Comparative analysis of cadet involvement in research activities.

<table>
<thead>
<tr>
<th>Marine specialties of Admiral Ushakov Maritime State University</th>
<th>Number of first-year cadets</th>
<th>Number of cadets with research skills</th>
<th>Number of cadets of the first stage (1-2 years of study) participating in various areas of research and development activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation</td>
<td>281</td>
<td>8.3%</td>
<td>48.1%</td>
</tr>
<tr>
<td>Operation of marine power plants</td>
<td>193</td>
<td>7.6%</td>
<td>35.6%</td>
</tr>
<tr>
<td>Operation of ship electrical equipment and automation equipment</td>
<td>57</td>
<td>7.4%</td>
<td>32.4%</td>
</tr>
<tr>
<td>Technical operation of transport radio equipment</td>
<td>60</td>
<td>5%</td>
<td>21.7%</td>
</tr>
</tbody>
</table>

During the survey, the cadets of the fifth (graduation) year confirmed (92%) the need to use the elements of research activities at all stages of training and emphasized the need to organize such work at the first years of training during the study of basic disciplines.

Most of the cadets (74%) note that the organization of research activities at all stages of training would allow writing a final qualification paper at a higher research or scientific level. A survey on professionally significant issues confirms (57%) the significance of the developed
research skills obtained during the research activities at the university. Graduates note (63%) that the percentage of those wishing to further engage in research activities (those entered the post-graduate school) would be higher with the active inclusion of cadets at the first stage of training in the research activities.

We conducted a comparative analysis of the research work of cadets of the first (initial stage) and third (intermediate stage) years of study (Table 4). The results of the analysis show that purposeful work on organizing research activities by the teachers of basic departments increased the interest of cadets in studying disciplines, made it possible to master the skills of searching and analyzing scientific information, planning and conducting experiments, rules for writing abstracts, project-based work, and a reference list.

It is important that while mastering the skills of research activities at the maritime university, the cadets willingly share their experience with schoolchildren and help in the development of the following skills:

- mathematical modeling;
- physical experiments, including mechanical, optical, thermal, acoustic, electrical measurements;
- design, creation, editing and analysis of 3D models;
- development of 3D printing technologies;
- study of the vessel design;
- study of vessel motion: motion of bodies in a stationary medium, flow of fixed bodies in a moving medium and motion of bodies in a moving medium;
- development and operation of mechanical and electrical measuring and recording equipment;
- training in modern specialized program packages;
- training in programming and high-performance computing.

4 Conclusion

The research work of cadets at a maritime university described in this paper allows at the first stage (1-2 years of study) not only increasing the level of professional knowledge, contributing to self-education and self-development, being able to make decisions and taking responsibility, but also creating new research projects and directions in the transport marine industry.

The practical significance of the work lies in the organization of research activities of cadets during the study at the university at the first stage (1-2 years of study), increasing cognitive interest, professional motivation, creative activity, allowing students to reach a certain research level in thesis or research works.

Further research on this issue should be considered in the following areas:

1. Creation of a methodological manual on the organization of research activities of cadets of a maritime university with a description of the forms and methods of research activity, including final qualification papers (in development).
2. Organization of a virtual laboratory for the research activities of cadets at the university, which includes various forms of work (the main areas of such activity are reflected in the first university collection Scientific Digest [13]).

References

2. A.N. Tomilin, S.I. Pankina, S.N. Tomilina, A.M. Dorofeev, E.M. Dorofeev, To the question of understanding the essence of the human factor by the ship's crew members and their predisposition to create an emergency situation, Operation of Marine Transport 2(103), 50–56 (2022)
7. I.E. Klimova, Development of the scientific and research culture of a teacher: Doctoral dissertation (Orenburg, 2001)
8. A.V. Moskvina, Scientific and practical foundations of the formation of intellectual creativity of high school students in the system of pedagogical interaction: Doctoral dissertation (Orenburg, 2006)
12. S.I. Pankina, Formation of research skills of students of economic specialties in the process of professional training at the university: PhD dissertation (Magnitogorsk, 2009)

13. Digest of student science of Admiral Ushakov Maritime State University 47 (Novorossiysk, 2021)

