Research component in training of transport specialists

M G Golubchikova¹,², S A Harchenko², A A Byshlyago³, A I Korobchenko³, G V Golubchikov⁴, M V Panichkina⁵

¹Irkutsk State Medical Academy of Postgraduate Education - a branch of the Russian Medical Academy of Continuing Professional Education, Ministry of Health of Russia, Irkutsk, Russia
²Irkutsk State University, Irkutsk, Russia
³Irkutsk State University of Railway Engineering, Irkutsk, Russia
⁴East Siberian Branch, Russian State University of Justice, Irkutsk, Russia
⁵Southern Federal University, Taganrog, Rostov-on-Don, Russia

E-mail: mariam_rav@mail.ru

Abstract. A specialist in the field of transport systems must have high educational and professional independence, in the process of his future professional activity, constantly develop his competencies and master new ones. In particular, he needs to possess developed research skills, to be ready to solve new problems constantly arising in transport. The article proposes the author’s approach to the formation of educational and professional independence of future transport specialists, aimed at the development of research skills. Based on the competence-activity approach, the authors propose a system of work on the formation of a research component in the competences of a future transport specialist as part of the formation of his educational and professional independence. The materials of the article contain a description of the pedagogical experiment and the results of the pedagogical experiment on introducing the proposed ideas into the educational process of the railway university. The study was carried out on the basis of the Federal State Budgetary Educational Institution of Higher Education “Irkutsk State University of Railways”.

1. Introduction
The higher education system in the transport system is actively transforming after the numerous, intensive and multidirectional socio-economic changes taking place both in a single country and in the world. The state, business, and, consequently, society, need specialists who are able to think independently, constantly improve their knowledge, ready to adapt in conditions of rapid progress, to see emerging problems and ways to solve them in the field of professional activity. In the transport sector, such specialists are the key to uninterrupted and safe transport communications.

The relevance of the problem of the formation of educational and professional independence of students of a transport university is due to socio-economic and scientific-technical transformations in modern society. The activities for which a graduate of a transport university should be ready is determined by the educational and professional standards approved in the state, as well as by the specifics of the student’s further professional interests as a future specialist. The Federal educational standards of higher education in Russia provide requirements for the implementation of basic professional educational programs in the form of universal and general professional competencies of a transport specialist.
In the context of this article, we would like to dwell on the relevance of the formation of such a component of educational and professional independence as the independence of a future specialist in the field of transport in research activities.

Having analyzed the Federal standards in four specialties of the “ Technique and technology of ground transport” direction: 05.23.03 “Rolling stock of railways” [1], 05.23.04 “Operation of railways” [2], 05.23.05 “Systems for providing train traffic” [3], 05.23.06 “Construction of railways, bridges and transport tunnels” [4], we found that the research component of the educational and professional independence of students is quite pronounced. The competencies that are part of the data structure and standards are closely related to the research characteristics of educational and professional independence, we will present in the form of a table (table. 1).

Table 1. Research competencies in the structure of Russian Federal educational standards of higher education for transport specialists.

| Type of competency | Name of competency category | Competency Content |
|--------------------|-----------------------------|--------------------|
| Universal          | Systemic and critical thinking | Able to carry out a critical analysis of problem situations based on a systematic approach, develop an action strategy (UK-1) |
| General professional | Mathematical and natural-scientific analysis of problems in professional activity | Able to solve engineering problems in professional activities using the methods of natural sciences, mathematical analysis and modeling (GPK-1) |
|                    | Legal and technical basis of decisions in the field of professional activity | Able to make decisions in the field of professional activity, using the regulatory framework, theoretical foundations and experience in the production and operation of transport (GPK-3) |
|                    | Research                      | Able to formulate and solve scientific and technical problems in the field of his professional activity (GPK-10) |

The considered universal and general professional competencies are formulated identically for different specialties within the same direction. Whereas the professional competencies established by the specialty program are formed on the basis of professional standards. And this means that the competencies of a university graduate must correspond to the qualifications required to carry out a certain type of professional activity.

The analysis of professional standard 17.037 “Inspector for the safety of train traffic” [5] shows that in generalized labour functions, which are considered as a complex of labour functions, together with the necessary knowledge and skills, the research character is determined, namely, the performance of labour actions in the process of professional activity such as: “the study of positive experience in ensuring the safety of movement and operation in railway transport; preparation of proposals for scientific and technological development and the main areas of technical policy in the field of ensuring traffic safety and operation in railway transport; analysis of the reasons for the occurrence of traffic accidents, events associated with the violation of the rules of safety of movement and operation in railway transport” [5].

In the professional standard 17.041 “Head of a railway station” [6], the following labour activities are described that are of a research nature: “analysis of the implementation of the main performance indicators of a railway station of III, II, I class and extra-curricular with appropriate measures; development of proposals to reduce operating costs at the railway station III, II, I class and extracurricular”[6].

In addition to meeting the requirements of professional standards, an employer is interested in a specialist who has an interest in his profession, the desire for independent knowledge of the new and
expanding the boundaries of his professional competence, and the desire to make a personal contribution to the improvement of engineering and production technology in his field of activity.

Thus, the analysis of professional standards and wishes of the employer allows us to state that the allocated labour functions, together with the necessary knowledge and skills, have a research component of educational and professional independence, and determine the need to prepare students of a technical university for independent research activity.

To achieve this goal, it is necessary to form the following groups of research skills among students: activity-related, intellectual, informational, communicative. The listed skills are formed through generally accepted forms of research work in the educational process of a university: laboratory work; writing essays; participation in subject Olympiads; preparation of reports; performance of tasks containing elements of scientific research; the implementation of specific non-standard tasks of a research nature during the period of training and production practices; the study of the theoretical foundations of the methodology, formulation, organization of the implementation of scientific research in courses of special disciplines and disciplines of specialization; term papers, dissertations and projects [7].

Traditionally, there are two types of research activities of students at the university:
- research activities of students, built into the educational process as part of the curriculum (in this case, it is usually called educational research activity);
- student research activities that go beyond the educational process (this type of activity is usually called research) [8, 9].

A small part of students is engaged in research activities at the university. Only a few have the ability and interest to deeply study individual issues of a particular subject area, allowing to obtain new scientific knowledge. In educational research, on the contrary, it is necessary to involve all students with the aim of teaching them research methods and techniques for obtaining knowledge. The result of such an activity for a student is knowledge that is new only to himself.

Based on the foregoing, “educational and professional independence in research” is considered by us as the ability of a future specialist to independently build all stages of research: orientation, planning, execution, monitoring, evaluation, correction and reflection in order to obtain new knowledge in accordance with intellectual requests personality and society.

Thus, in the process of preparing students for professional activities, great importance should be given to the formation of their educational and professional independence in research activities, which is due to the requirements of the Federal State Educational Standard and the professional standards.

Depending on the level of complexity of independently performed activities, the degree of severity of independence is distinguished. Comparing two students, one can always distinguish one who has a higher degree of severity of independence. A student with a more pronounced independence is concentrated on the task, counts only on his own strength, his awareness of activity is deeper, the desire to cope with the task above. Based on the analysis of the nature and content of the phenomenon of independence, we can conclude that researchers unanimously define independence as the most important personality characteristic, closely related to will, motivation, commitment, but still do not come to a single definition of this concept in connection with its versatility.

The study of psychological and pedagogical literature on the problem of the formation of independence made it possible to note the diversity of pedagogical techniques offered by teachers and psychologists on the formation of independence. The fact that this phenomenon is complex, ambiguous, and there are no studies on the formation of students' independence in research activities allows us to conclude that it is necessary to consider possible solutions to this problem.

2. Materials and Methods
The purpose of this part of the study, we determined the search for ways of forming educational and professional independence in the research activities of future experts in the field of transport.

Work on the formation of students' competencies within the educational process of the university should be systematized and have a methodological basis. In our study, we relied on a philosophical
understanding of the process of assimilation by the subject of the experience accumulated by mankind (K. Marx, E.V. Ilyenkov, T.F. Mikhailov), the cultural-historical concept of assimilation of social experience and the psychological theory of activity (L.S. Vygotsky, A.N. Leont’ev, P. Ya. Halperin).

The basis of our joy also served as the works of OM Kolomiyets, who develops the idea of organizing student learning activities in accordance with the psychological nature of human activity [10], developed her understanding of the competence-activity approach to education [11], which reveals the psychological nature of the process of learning material in the context of the cultural-historical theory of mastering social experience.

In the educational process, the assignment of social experience by an individual acts as a universal form of activity - theoretical, during which the student learns not only the object of study, but also the methods, means, forms and other conditions of theoretical activity, which are its methodological tools. The theoretical activity of a student is associated with internalization aimed at building a mental image of the object of study in the student’s mind. Thus, the subjective image of students is formed. Further, in the process of exteriorization, this image acts as a function of orientation in relation to independent practical, in our case, research activity.

The system of work on the formation of the independence of students of a transport university in research involves the formulation of components of independence in research, the planning of stages of activity and the development of didactic tools designed to build students’ independence in research.

To achieve the goal of our work, the following research methods were used:
- theoretical methods: study and analysis of psychological and pedagogical literature on the research problem, analysis of dissertation research, comparative analysis, synthesis, analogy, comparison, generalization.
- empirical methods: observation, questioning, testing, pedagogical experiment.

The following methods were included in the diagnostic complex: questionnaire “Analysis of motivational states”, test “Theoretical foundations of research activity” [12], methods for assessing the level of formation of the activity component [10], diagnostic methods for the development of reflexivity according to A. V. Karpov [13].

The study was carried out on the basis of the Irkutsk State University of Railways Federal State Budgetary Educational Institution of Higher Education.

The essence of the pedagogical experiment consisted in the implementation of a system of work for the formation of educational and professional independence of students in research activities.

The experiment on the formation of students’ independence in research was carried out with graduate students in the form of group consultations in addition to consultations conducted by their leaders.

At the same time, we identified several stages of work with students.

1. Motivational stage - the emergence of the need to engage in research activities when performing graduate qualification work.

   Goal setting - setting a goal to perform graduate qualification work with elements of research work. At this stage, the student needs to determine for himself:
   - skills that need to be mastered or automated - what practical tasks to learn to solve;
   - knowledge that needs to be acquired for this;
   - skills that need to be improved;
   - competency to be mastered or to be developed;
   - types of activities that need to be improved;
   - qualities (personal, professional) that need to be developed.

2. The stage of analysis of “indicative” knowledge, skills, educational material - that is, previously learned by a student from related subject areas, acting in an indicative function in relation to the research process in the framework of the graduation project.

   At this stage, the student must:
   - to repeat and evaluate the level of possession of previously acquired by the student knowledge, abilities and skills necessary to perform graduate qualification work;
- present in the reference tables and reference maps the “missing” knowledge that will need to be
guided.
3. The stage of the implementation of educational and research activities aimed at acquiring a
materialized image of the upcoming research activities.
   At this stage, the student will:
   - conduct orientation in the structure and content of research activities;
   - plan upcoming research activities;
   - perform research tasks;
   - conduct a reflection of the development of research activities.
3. The stage of generalization and systematization of the new knowledge obtained in educational
research activities on the development of research activities in supporting tables (OT) and supporting
maps (OK).
   At this stage, the student must:
   - in the supporting tables present the elements of knowledge in a systematic structural form;
   - in the base maps to reveal the structure and content of activities to solve practical problems.
4. The stage of internalization of knowledge, which is generalized and systematized in the
reference tables and reference maps.
   At this stage, the student must complete:
   - solving practical problems based on OT and OK, acting in an indicative function;
   - solving logical problems aimed at the development of logical, conceptual, systemic thinking as
     the basis of professional thinking;
   - use in the process of solving practical problems of different forms of speech (loud speech, speech
     "to oneself", mental speech);
   - solving practical problems, first in joint activities distributed with other subjects of the
     educational process, then in pairs with them, then individually.
5. The stage of determining the personal meaning of the activity in relation to the formation or
automation of skills, mastering the knowledge system, developing skills, mastering the types of
activities necessary to carry out independent research as part of the final qualification work, which
were determined at the goal-setting stage.
   As part of this stage, the student will:
   - independent research in the framework of final qualification work;
   - conducting self-control (by key) and searching for deviations from the “normative option” (errors,
inaccuracies);
   - conducting a self-assessment: determining the “nature” and “reasons” of the deviation found from
     the “normative option”;
   - self-correction behaviour of tolerances based on OT and OK: selection of another, “correct”
     knowledge; performing another, “right” action, etc.
6. The stage of reflection of the performed research activity, final qualification work.
   As part of this stage, the student will determine the suitability of the work done to the goal and
answer for themselves the following questions:
   - what skills were formed, developed, automated (i.e. what practical problems the student learned
to solve);
   - what concepts are learned;
   - which system of new knowledge is learned;
   - what skills were improved;
   - what competence was formed, developed;
   - what types of activities mastered;
   - what qualities (personal, professional) he developed;
   - what personal sense does the performed activity have, etc.
This psychological structure and content of the student’s educational and professional activities have become the basis for us in organizing the educational process in a transport university, aimed at creating students’ independence in research activities.

3. Results
Based on the content and structure of independent research activities, we have identified its components. The possibility of students independently conducting their research is based on their personal interest - motivation, on their theoretical knowledge about conducting research activities, on their skills in this activity.

Thus, we distinguish the following components of independence in research activities: motivational, cognitive, and activity. The formation of each component can be estimated based on criteria, while levels act as a meter. We highlighted high, medium and low.

The motivational component is the meaning that research activity has for a person, determines the interest and conviction in the need for research activity in the process of self-realization in the profession.

The motivational component can be assessed by the severity of the following criteria: independent choice of research topic; active participation in research activities; desire for self-development, for the development of material not provided for by the program; the need for self-realization through research.

With a high level of formation of the motivational component, the student shows a steady interest in research activities; able to independently choose the direction and topic of his research work; takes an active part in research activities; seeks to show individuality, non-standard in the approach to solving problems when performing research; self-fulfilling through research activities, i.e. students embody their inclinations and capabilities in it.

At an average level, interest in research is not always stable; the student needs help in choosing the direction and topic of the research work; activity in self-development is low, but shows interest in considering additional material; a student can self-actualize only through the implementation of certain operations of research activity.

Low level of motivational component - shows situational interest in research activities; the student is not able to choose the direction and topic of research work; capable of completing simple tasks under the guidance of a teacher, but there is no activity and perseverance in their implementation; does not show activity in self-development or it is not high, do not seek to learn more than curricula offer; does not connect research activities with personal self-realization.

The cognitive component determines the degree of development of the conceptual apparatus, the ability to use the formed theoretical base in the process of research activity.

Criteria of the cognitive component: knowledge of the requirements for research projects; knowledge of the methods for carrying out research activities, the conditions for their application; knowledge of the methods of processing and presenting data and research results.

With a high level of cognitive component formation, the student knows the requirements for research projects; research methods and conditions for their use; ways of processing and presenting data, as well as research results. The student is able to freely use theoretical concepts in the research process.

Intermediate level - the student has fragmentary knowledge about the requirements for research projects, research methods and the conditions for their application; He knows some methods of processing and presenting data, as well as research results, relying on previously studied, considered analogues. Knowledge is limited to the curriculum.

At a low level, the student does not have sufficient knowledge about the requirements for research projects, about research methods, the conditions for their application, about the methods of processing and presenting data to carry out the research on their own. There is enough knowledge to carry out the most simple research tasks.
The activity component determines the degree of mastery of the methods for carrying out research actions, the possibility of applying the formed skills, methods of action and accumulated knowledge in practice.

The level of formation of the activity component can be measured by criteria corresponding to the stages of activity: orientation of the upcoming activity; research planning; organization of research; monitoring and evaluation of research results; adjustment of further work depending on the results; reflection.

A high level according to all criteria of the activity component indicates that the student is able to show independence at each stage of the research activity. Able to self-control, self-esteem and self-correction of their activities. Moreover, all actions of the student are accompanied by reflection.

At an average level, the student is able at some stages to show independence, at others he needs little help from the teacher or fellow students. The student also demonstrates a situational manifestation of self-control, self-esteem, self-correction and reflection.

The low level of the activity component signals the student’s complete unpreparedness to go through all the stages of research activity independently without the help of a teacher. The student expects control, evaluation and correction only by the teacher. His activity is not accompanied by reflection.

Data on the number of students and the percentage of each of the levels, for clarity, were summarized in a summary table of the results of the ascertaining and control experiments (Table 2). In total, 30 graduate students participated in the study.

| Levels   | "Motivation" | "Theoretical knowledge" | "Research activity" | "Reflexivity" |
|----------|--------------|--------------------------|---------------------|--------------|
|          | Before, %    | After, %                 | Before, %           | After, %     |
| Low      | 30           | 20                       | 60                  | 0            | 40           | 0            | 20           | 20           |
| Middle   | 40           | 30                       | 40                  | 30           | 50           | 20           | 60           | 50           |
| High     | 30           | 50                       | 0                   | 70           | 10           | 80           | 20           | 30           |

Changes in the level of formation of educational and professional independence in research activities were monitored by the same components that were used at the ascertaining stage of the experiment: motivational, cognitive, and activity.

The educational and professional independence of students - future transport specialists - is a comprehensive education that includes resistance to stressful situations and self-regulation, based on active understanding, research on the surrounding reality [14, 15, 16]. Such an understanding is both part of the development of programs based on the state standard, as well as programs included in additional and global education aimed at developing reflexivity, self-regulation, ability and willingness to explore and regulate the internal and external world [17-21].

4. Discussion
In accordance with the data obtained, there is a positive dynamics of indicators for all diagnostic methods. Intensive progress was noted in the development of the activity component. The level of theoretical knowledge in a significant part of the respondents of the experimental group rose to a high level. Against the background of an increase in these indicators, motivation for some students increased.

In addition, during the implementation of the formative stage of the experiment, we were able to influence the creation of a favourable psychological climate in the group. This happened due to the creation of active participation and personal interest in the implementation of the final qualification work of each student.
5. Conclusions
The presented research experience opens up prospects for further developments aimed at studying related issues of the stated multi-aspect problem. The study does not exhaust the fullness of the problem and causes the emergence of new issues that need to be addressed: determining the factors and conditions for the continuity of the formation of independence in the research activities of bachelors, masters and graduate students of technical universities. The problem considered in the study is complex and multidimensional, we believe that the study will to some extent help solve the stated problem, and can also become the basis for its new promising developments.

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