

УДК 378.14

DOI: 10.17238/issn1998-5320.2020.14.2.19

M. G. Golubchikova^{1,2}, A. A. Byshlyago³¹ Irkutsk State University, Irkutsk, Russian Federation² Irkutsk State Medical Academy of Postgraduate Education – a branch of the Russian Medical Academy of Continuing Professional Education, Ministry of Health of Russia³ Irkutsk State Transport University, Irkutsk, Russian Federation

Organization of independent research work of technical university students

Abstract. Research Problem – the search for effective ways to organize independent research work of technical university students considering it as the basis to shape professional competence of a future specialist. The authors suggest that the organization process for independent research work of technical university students will be effective if an integrated approach to the problem of students independence in research work is implemented in the framework of training future specialists for professional activities; a system of work shaping independent research work of technical university students has been developed and introduced taking into account the psychological nature of the mastering process.

The study involved students of Specialist Degree program at Irkutsk State Transport University going through specialty 05/23/04 “Operation of railways”, the group consisted of 30 people, including 7 girls and 21 young men.

We adapted some diagnostics developed by different authors and adjusted them to the conditions of this study. The motivational component was diagnosed using the method by O. O. Gorshkova. The cognitive component was evaluated while testing students in order to identify the level of their conceptual apparatus development, the ability to use the shaped theoretical base in the process of research activity. The activity component was studied with the use of the method by O. M. Kolomiets based on work with reference cards. The method by A. V. Karpov was used to study the reflection ability.

The ascertaining experiment results showed low and medium indicators of the maturity level of students’ independent research activities taking into consideration all components; the result could be explained by their weak willingness for this activity.

There was a positive dynamics in indicators for all diagnostic methods after the formative experiment. Intensive progress was noted in the activity component development. The degree of theoretical knowledge in a significant part of the experimental group respondents rose up to a high level. Against a backdrop of an increase in these indicators, the motivation of most students boosted.

An increase in the efficiency of the process of forming independent research work of technical university students can be achieved by introducing a system of work shaping independent research work of technical university students taking into account the psychological nature of the mastering process.

Keywords: independence, independence in research activities, mastering process, interiorization, exteriorization, competence- and activity-based approach.

Paper submitted: April 29, 2020

For citation: Golubchikova M. G., Byshlyago A. A. (2020). Organization of independent research work of technical university students. The Science of Person: Humanitarian Researches, vol. 14, no. 2, pp. 113–117. DOI: 10.17238/issn1998-5320.2020.14.2.19

Introduction. Modern production and society are in desperate need of highly qualified specialists able to carry out their labor functions in a continuously and rapidly changing environment. Widespread introduction of new technologies makes high demands of specialists in any field of activity. Literacy, commitment, dynamism, the ability to independently use new scientific data, to organize one’s research and implement one’s inventions solving professional problems are becoming mandatory characteristics of a modern specialist.

Profound analysis of the “Transport Logistics Specialist” professional standard shows that the labor functions determine the research character and the research activities carried out in the process of professional activity, namely, the requirement is: “To summarize and systematize information with regard to tasks; to possess skills necessary to use analysis methods employed in practice to solve the problem of commercial policy development concerning the provision of logistics services for the cargo shipping; to forecast and analyze trends of logistics and supply chain

management development; to develop an action plan to achieve financial performance indicators of the goods transportation within the supply chain in a prompt and skillful way” [1]. A modern student as a future specialist must be ready to work in accordance with the professional standard.

But, unfortunately, the practice of future Russian specialists training indicates that their level of willingness for research work does not meet modern requirements. The educational system of technical universities does not create favorable environment for students to become independent in research work, it does not reveal their creative potential and it does not contribute to their personal and professional development to the full extent. There is a contradiction between the social requirements to train creative and forward thinking experts who are capable to solve professional problems using their independent researches, and the real specialists training in the university based on algorithmic activity.

The need to resolve this contradiction made it possible to shape the research problem: the search for effective ways to organize

independent research work of technical university students considering it as the basis to shape professional competence of a future specialist.

The purpose of the study: theoretical justification, development and implementation in the educational process the work system shaping technical university students independence in research activities.

Research hypothesis: the process of shaping technical university students independence in research activities can be effective if:

- an integrated approach to the problem of students' independence in research work is implemented as part of future specialists training for professional activities;
- a work system is developed and introduced to form technical university students independence in research activities taking into account the psychological nature of the mastering process.

Research program. The following research methods have been used to achieve the goal of the study,:

- theoretical methods: study and analysis of psychological and pedagogical literature on the research problem, analysis of dissertation researches, comparative analysis, synthesis, analogy, comparison, generalization;
- empirical methods: observation, questionnaire, testing, pedagogical experiment.

The study was carried out at the Federal State Budgetary Educational Institution of Higher Education "Irkutsk State Transport University". It involved students of specialty 05/23/04 «Operation of railways», the group consisted of 30 people, including 7 girls and 21 young men.

The study has been conducted for two years (2017–2019), it consisted of three stages.

1. The theoretical stage i.e. the analysis of pedagogical, psychological and methodological literature on the topic of research in order to identify the degree of problem development. As well as the definition of methodological approaches, techniques, object, subject, conceptual apparatus of the study and the working hypothesis.

2. The experimental stage means the implementation of actions related to the development of a work system shaping students' independence in research activities and also related to its experimental verification. This stage includes ascertaining, formative and control experiments.

3. The summarizing stage is the analysis and generalization of the research results, as well as their refinement, control and correction. This stage is also characterized by systematization, generalization, interpretation of the experimental activity results.

At the theoretical stage in the course of literature analysis we settled on the competence- and activity-based approach considering it as the main methodological basis [2]. Relying on this approach in the theoretical part of the work, we have framed the definition of students' independence in research activities; we understand it as the ability to independently design all stages of research activity: orientation, planning, execution, control, evaluation, correction and reflection in order to obtain new knowledge in accordance with the intellectual demands of the individual and society. Independence in research work includes a motivational, cognitive and activity components. Having analyzed the works of the representatives

of the activity-based approach (P. Ya. Halperin, Z. F. Reshetova, O. M. Kolomiets) [2–5], we came to the conclusion that shaping students' independence in the process of their own research implementation can be carried out when student's educational activities are organized according to psychological nature of the mastering process. Besides the process of exteriorization should be preceded by the interiorization stage with valuable educational, research and practical activities, though, as a rule, students take part in exteriorization stage without necessary training.

The identification of the initial maturity level of students' independence in research work was carried out according to the developed components, namely motivational, cognitive and activity ones.

The motivational component assessment was carried out by determining the level of motivational component maturity using questionnaire methods and pedagogical observation. The diagnostics developed by O. O. Gorshkova were used as a toolkit but they were adapted to the research conditions [6].

The cognitive component was evaluated by testing students to identify the degree of conceptual apparatus maturity and the ability to use the shaped theoretical base in the process of research activity. If a student had enough knowledge to give correct answers to more than 70% of the questions asked, the level of his cognitive component maturity was assessed as a high one. Hence, he had grounded knowledge of the research tasks types, knew the requirements for research results and knew research methods and conditions of their application. The level was estimated as an average one, if the number of correct answers was about 35–69 %. If a student's score was less than 34 %, his cognitive component was attributed to the low level.

The methodology based on reference cards by O. M. Kolomiets [5] was applied to assess the level of activity component maturity in research activity, this methodology made it possible to diagnose possession of all activity stages necessary to set up the research. The reflection ability is a part of the activity component; therefore, an individual measure of reflexivity was also determined using the method by A. V. Karpov [7]. Students were given a questionnaire consisted of 27 items; the items are answered on a 7-point Likert scale.

Relying on the theoretical provisions of our study, we have identified several stages of our work with students revealing in detail the process of interiorization preceding exteriorization.

1. Motivational stage i.e. the emergence of the need to be engaged in research activities carrying out graduate qualification work.

2. Goal-setting stage i.e. setting a goal for graduate qualification work with elements of scientific research work.

At this stage a student needs to determine for himself:

- skills to be mastered or automated, practical tasks to be learnt to solved;
- knowledge to be mastered to reach this goal;
- skills to be improved;
- competencies to be mastered or to be developed;
- types of activities to be improved;
- (personal, professional) qualities to be developed.

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

At this stage a student has to:

- to revise and evaluate the level of previously acquired knowledge, skills and abilities necessary to carry out his graduate qualification work;

- picture in reference tables and reference cards the knowledge gaps; this knowledge will be of help.

4. The stage of the educational and research activities implementation; they are aimed at acquiring a materialized image of the upcoming research activities.

At this stage a student has to:

- orientate in the structure and content of research activities;
- plan upcoming research activities;
- perform research tasks;
- reflect the research activities development.

5. The stage of generalization and systematization of new knowledge gained in educational research activities referring to research activities mastering in the reference tables (RT) and reference cards (RC).

At this stage a student has to:

- present the elements of knowledge in a systematic structural form in the reference tables;
- reveal in reference cards the structure and content of activities focused on practical problems solution.

6. The stage of educational and practical activities aimed to transfer knowledge into the mental plan; the knowledge has already been generalized and systematized in the reference tables (RT) and reference cards (RC)

At this stage a student has to carry out:

- practical problems solution on the basis of RT and RC having an indicative function;
- logical problems solution aimed to develop logical, conceptual and systemic thinking as the basis of professional thinking;
- different forms of speech (loud speech, «to oneself» speech, mental speech) in the process of practical problems solution;
- practical problems solution, first in joint activities distributed between the subjects of the educational process, then in pairs with these people, then individually.

7. The stage of determining the personalized meaning of the activity in relation to the maturity or automation of skills, the knowledge system mastering, skills development, mastering different types of activities necessary to carry out independent research as part of the final qualification work; they were determined at the goal-setting stage.

In the framework of this stage, the student will have to:

- carry out an independent research in the framework of his final qualification work;
- conduct self-control (using the key) and search for deviations from the “standard variant” (errors, inaccuracies);
- conduct the self-assessment: to determine the “nature” and “reasons” of the deviations from the “standard variant”;

- conduct self-correction of deviations basing on RT and RC: selection of another “correct” knowledge; performance of another “correct” action, etc.

8. Stage of research activities and the graduate qualification work reflection.

- what skills were formed, developed, automated (what practical problems did the student learn to solve);

- what concepts are learned.

In the framework of this stage, a student will have to determine the compliance of the work performed with the goals and answer the following questions:

- what system of new knowledge is learned;
- what skills were improved;
- what competence was shaped, developed;
- what kind of activities did you master;
- what qualities (personal, professional) did you develop;
- what personalized meaning does the performed activity have, etc.

This structure and content of the student’s educational and professional activities became the basis for the educational process organization in a technical university aimed at shaping students’ independence in research activities.

Results and their interpretation. Alterations in the maturity level of research activities independence were monitored according to the same components used at the ascertaining stage of the experiment: motivational, cognitive, and activity-based ones.

The data obtained in the process of repeated questioning showed that 20 % of students in the experimental group had a low level; it is 10 % lower than it was at the control stage; the number of students with an average level decreased by 10 % and made up 30 %, while 50 % of students showed the high level, but only 30 % of students demonstrated the high level at the control stage.

The results of the repeated “Theoretical Foundations of Research Work” testing showed a positive trend in the experimental group: the increase in the high level was 70 % and there were no students with the low level. 30 % of students demonstrated an average level; it was 10 % less than according to the ascertaining experiment results.

The data obtained in the process of repeated activity component diagnostics showed that not a single student of the experimental group showed the low level, but at the ascertaining stage of the study 40 % of students had the low level. The number of students with the high level was 80 %, at the same time 20 % of the students showed the average level, but at the ascertaining stage of the study the average level was reached by 50 % of the students.

The results obtained during the re-diagnosis of an individual measure of reflexivity according to the A. V. Karpov method did not undergo significant changes. In this case, the percentage of the high level results increased by 10 %, at the same time the average result decreased by the same 10 %.

Thus, we observe a difference between the ascertaining and control experiments results after the performance of formative experiment.

Findings. Analyzing the results obtained during the control experiment, we came to the conclusions confirming our assumption

that an increase in the efficiency of the process of forming independent research work of technical university students can be achieved by introducing a system of work shaping independent research work of technical university students taking into account the psychological nature of the mastering process.

The results of the ascertaining experiment showed low and medium indicators of the level of students' independence in research activities for all components, which was explained by their weak willingness for this activity.

In accordance with the data obtained, there was a positive dynamics of indicators for all diagnostic methods in the group of students having taken part in the experiment. The intensive progress was noted in the activity component development. The level of theoretical knowledge in a significant part of the experimental group respondents rose up to the high level. Against a backdrop of an increase in these indicators, the motivation of most students boosted.

In addition, during the formative experiment we were able to influence the creation of a favorable psychological climate in the group.

This became possible due to the active participation and personal interest of each student carrying out his final qualification work.

Thus, we can state the confirmation of the hypothesis about the increasing efficiency of the process shaping independent research work of technical university students by introducing a work system shaping independent research work of technical university students taking into account the psychological nature of the mastering process.

The theoretical significance of the study lies in the expansion of ideas about the students independence in research activities; identification of components, criteria and levels of students' independence in research activities; development and justification of a work system of shaping technical university students independence in research activities.

The practical significance of the study consists in the development of diagnostic tools fit for the research problem, in the possibility to use the presented work system shaping technical university students independence in research activities in the practice of higher education.

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Information about the authors

Marina G. Golubchikova

Cand. Sc. (Pedagogy), Associate Professor. Irkutsk State University (1 Karl Marx st., Irkutsk, 664003, Russian Federation).

Irkutsk State Medical Academy of Postgraduate Education – a branch of the Russian Medical Academy of Continuing Professional Education, Ministry of Health of Russia (100 Yubileiny m., Irkutsk, 664049, Russian Federation). E-mail: mg2@bk.ru

Anastasiya A. Byshlyago

Senior Lecturer. Irkutsk State Transport University (15 Chernyshevsky st., Irkutsk, 664074, Russian Federation). E-mail: apreina@yandex.ru

М. Г. Голубчикова^{1,2}, А. А. Бышляго³

¹Иркутский государственный университет, г. Иркутск, Российская Федерация

²Иркутская государственная медицинская академия последипломного образования
– филиал Российской медицинской академии непрерывного профессионального образования Минздрава России,
г. Иркутск, Российская Федерация

³Иркутский государственный университет путей сообщения

Формирование самостоятельности студентов технического вуза в исследовательской деятельности

Аннотация. Проблема исследования – поиск эффективных путей формирования самостоятельности студентов технического вуза в исследовательской деятельности как основы формирования профессиональной компетентности будущего специалиста. Авторы предполагают, что процесс формирования самостоятельности студентов технического вуза в исследовательской деятельности будет эффективным, если реализован комплексный подход к проблеме самостоятельности студентов в исследовательской деятельности в рамках подготовки будущих специалистов к профессиональной деятельности, разработана и внедрена система работы по формированию самостоятельности студентов технического вуза в исследовательской деятельности с учётом психологической природы процесса усвоения. В исследовании участвовали студенты специалитета Иркутского государственного университета путей сообщения, обучающиеся по специальности 23.05.04 «Эксплуатация железных дорог», в со-

ставе 30 человек, из них 7 девушек и 21 юноша. В качестве инструментария были применены диагностики, разработанные разными авторами и адаптированные под условия данного исследования. Мотивационный компонент диагностировался по методике О. О. Горшковой. Когнитивный компонент оценивался посредством тестирования студентов для выявления степени освоения понятийного аппарата, способности использовать сформированную теоретическую базу в процессе исследовательской деятельности. Деятельностный компонент изучался по методике О. М. Коломиец на основе работы с опорными картами. Для исследования способности к рефлексии использовалась методика А. В. Карпова. Результаты констатирующего эксперимента показали низкий и средний показатели уровня сформированности самостоятельности студентов в исследовательской деятельности по всем компонентам, что объяснялось их слабой готовностью к данной деятельности.

После проведения формирующего эксперимента отмечается положительная динамика показателей по всем диагностическим методикам. Интенсивный прогресс отмечен в развитии деятельностного компонента. Уровень теоретических знаний у значительной части респондентов экспериментальной группы поднялся до высокого уровня. На фоне увеличения данных показателей повысилась мотивация у большинства студентов.

Повышение эффективности процесса формирования самостоятельности студентов технического вуза в исследовательской деятельности может быть достигнуто путём внедрения системы работы по формированию самостоятельности студентов технического вуза в исследовательской деятельности с учётом психологической природы процесса усвоения.

Ключевые слова: самостоятельность, самостоятельность в исследовательской деятельности, процесс усвоения, интериоризация, экстериоризация, компетентностно-деятельностный подход.

Дата поступления статьи: 29 апреля 2020 г.

Для цитирования: Голубчикова М. Г., Бышляго А. А. (2020). Формирование самостоятельности студентов технического вуза в исследовательской деятельности // Наука о человеке: гуманитарные исследования. Т. 14. № 2. С. 113–117. DOI: 10.17238/issn1998-5320.2020.14.2.19

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Информация об авторах

Голубчикова Марина Геннадьевна

Кандидат педагогических наук, доцент. Иркутский государственный университет (664003, РФ, г. Иркутск, ул. Карла Маркса, 1). Иркутская государственная медицинская академия последипломного образования – филиал Российской медицинской академии непрерывного профессионального образования Минздрава России (664049, РФ, г. Иркутск, м-н Юбилейный, 100). ORCID ID: <https://orcid.org/0000-0002-7865-3031>. E-mail: mg2@bk.ru

Бышляго Анастасия Александровна

Магистр, старший преподаватель кафедры управления эксплуатационной работой. Иркутский государственный университет путей сообщения (664074, РФ, г. Иркутск, ул. Чернышевского, 15). ORCID ID: <https://orcid.org/0000-0003-1628-2981>. E-mail: apreina@yandex.ru