Innovative Forms of Students’ Independent Work in Modern Technical Education

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Abstract. Recent social, economic and demographic changes are setting new challenges for public education which require structural changes. A priority task in engineering education is how to train competent personnel who would be capable to quickly respond to labour market demands and willing to engage in life-long learning. The innovative component of the educational process in the new paradigm of higher education says that a student should be encouraged to be independent in learning. In the course of the transition towards a learning framework with a higher focus on independent learning there is a higher demand for face-to-face interaction with the teacher.

The authors argue that independent learning is an integral part of all the subject areas of higher education and that it should be considered as a holistic phenomenon and a complex system. The unique feature behind independent learning is that the student not only gains knowledge of the subject but also develops basic competencies that help his/her adaptation in professional sphere, such as analysis, planning, self-adjustment and self-assessment.

The solution proposed by the authors is to take into account the communication and polydialogue approach when defining the subject of education in the context of the competence- and activity-based paradigms by bringing metacognitive, cognitive, compensation and collaboration learning strategies in independent learning. The authors distinguish two aspects with regard to the above strategies: strategies as an intellectual behaviour of the student aimed at faster and more efficient learning and strategies as ways to process information for better understanding and retention.

1. Introduction

To date, one of the key problems of the Russian economy, which is the need to increase its competitiveness, is due to the inconsistency of the higher education system with modern requirements to the quality of human capital [1]. An innovative economy in the conditions of a globalized social space urgently requires the reform of the traditional domestic system of teaching and educational processes. Therefore, the adopted course of development of the education institute within the framework of the competence approach transforms the very structure of education.

Among the scientific publications in this area the works of the following authors could be marked: M.P. Akhmetzyanova, V.A. Zhilina, M.S. Teplykh, E.G. Chernova, A.I. Nazaricheva, L.R. Slobozhankina [2], N.R. Balynskaya, N.V. Kuznetsova [3], A.V. Gilyun, L.A. Kolesnik [4], L.S. Kiseleva [5], V.S. Kukushin [6], S.V. Kulnevicha [7], I.G. Minevrina, S.V. Abramova, E.N. Boyarov, A.S. Lomov [8], A.A. Smolkin [9], L.V. Tsiganov [10], A.A. Tsytsarev [11], P. Ricaurte [12], J. Steele, P. Steele [13], D.M. Ogley [14], M. Willerman, R.A. Mac Harg [15], J.E. Twinling [16].

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In the higher education system, the dominant role in the new paradigm is given to Students' Individual Work (SIW), which is considered simultaneously as a mechanism for introducing the student to knowledge and as a factor in improving the effectiveness of the results of information technology of the educational system, which is the medium for implementing competence and personality-oriented approaches in education [17,18].

A "new" specialist is a specialist capable of promptly responding to ongoing social changes, modifying his own professional activity in the direction of adequacy to the social order being formed. The specialist of such type is able to look for reserves of professional growth, is capable of constantly learning and self-extracting "new knowledge". Building an educational process, taking into account a practice-oriented approach, becomes a strategic direction for the development of vocational training in conditions of an innovative economy [19,20].

And it entails profound transformations: at the macro level in the processes of knowledge production and capital accumulation; at the middle level in the transformation of educational institutions; and at the micro level in the learning processes, which should be understood as complex interdependent relationships [12].

In addition, the most important distinctive features of the prospective education system are the fundamentalization of higher education as a tool to improve its quality and the outrunning character of the whole system, its focus on the problems of the oncoming post-industrial civilization and the development of the creative abilities of man [8]. The information society urgently requires the upbringing and education of a new subject who is able to implement an adaptive choice in the sphere of professional competences [5]. The present engineer and, especially, the future one must be able to surpass the existing technical reality [11]. This determines the strategies of innovative processes in technical education today - self-development and productive self-realization of a student with the skill of actively constructing one's own knowledge on the basis of analysis of alternative sources, knowledge of related disciplines. An important component of the SIW is the inculcation of self-assessment and self-monitoring activities of students.

Specificity of SIW as an element of training is the need for students to gain experience in the role of the teacher: analysis, planning, regulation and evaluation of their own activities. Hence the effectiveness of the SIW organization directly depends on the extent to which the student has mastered the learning strategies [10]. Technical education is always practice-oriented. It is especially important for the student to plan the sequence of the performed activities, to develop an algorithm of certain procedures, to build a schedule for the implementation of the prescribed stages, ensuring the effectiveness of the activity [21]. Accordingly, today in technical education in the SIW implementation, it is advisable to orient the student to master metacognitive, cognitive, compensatory, social strategies. The latter are defined by the authors in two ways: strategies as the intellectual behaviour of the student in the learning process with the aim of faster and more effective mastering of knowledge and strategy as ways of processing information that improve its understanding and preservation.

If metacognitive strategies are universal in the educational process and allow to improve the self-determination skill of one's own self, then the remaining strategies have differences in deployment in the sphere of technical education. In the cognitive strategies for the student of technical universities, the skills of working with information presented in the fusion of visual data of computer technologies, in ascertaining technical knowledge and the updated technical vocabulary of the language acquire special significance. In compensatory strategies, the student should focus more on the methods of finding supports. Possessing this skill in the process of individual work, the student is able to allocate meaningful fragments of knowledge for him, saving time, which is significant for his subsequent professional activity, where he will implement the competences obtained in the course of training. Strategies for educational cooperation already within the framework of the SIW begin to form the prerequisites for joint project activities, the mastery of which is aimed at modern technical education. These strategies mean the taxonomy of learning objectives in the organization of the SIW and allow us to distinguish the following main steps in its implementation by a student at a technical university:
simple reproduction of knowledge, work by algorithm or model, individual reconstruction of knowledge, heuristic individual work and, finally, individual research work.

We outline the practice-oriented SIW, which in the context of the provisions of the competence approach performs the following functions: 1) stimulates interest in the proposed new, facilitating the acquisition of knowledge, the formation of professional skills, also ensures the formation of professional competencies; 2) contributes to the development of independence, responsibility and organization, creative approach to solving problems of educational and professional levels; 3) creates the conditions for the student to develop a psychological attitude toward an independent systematic replenishment of his knowledge and develop skills to orient himself in the flow of information when solving new educational and professional problems [17,21].

The analysis of the educational process organization in the "Nosov Magnitogorsk State Technical University" revealed the strengthening of the practice-oriented orientation of the training of students through a system of classroom and extracurricular individual work (Table 1). In addition, the redistribution of the work types of the education process in favour of individual work occurs against the background of the requirement of increasing the time for personal communication with the teacher.

**Table 1. Types of students’ individual work.**

| Extracurricular SIW | In-class SIW |
|---------------------|--------------|
| - research work of students on a given topic; | - workshops-seminars; |
| - training, production, internship; | - practical project-type studies using the case-study method, using methods of situation analysis, using simulation exercises, trainings, methods of role-playing, brainstorming, MASTAC-technology (the method of active sociological testing, analysis and control); |
| - practice in obtaining skills and professional experience; | - practical studies using the method of modelling the professional environment (both of theoretical and of applied nature); |
| - project activity; | - practical studies - business and role games; |
| - entrepreneurial and business projects | - practical studies- lab sessions |

The study allows drawing conclusions about the distinctive features of the individual work of students in a Vocational Technical Institute in the context of the strategies being implemented:
- training is conducted in the situations those are as close to real as possible, allowing to introduce the learning material to be learned into the goal of the activity, rather than in the means;
- individual creative development of taking decisions is implemented, degree of motivation and emotionality of trained managers’ increases;
- trainees organize the formation of a new, qualitatively different facility for vocational training in the emotionally enhanced process of collective creative work (emphasis is on the practice-oriented component of vocational training);
- there is a forced activation of thinking, when the learner is forced to be active regardless of his desire, which helps to increase the effectiveness of the actualization of knowledge, skills, competencies of future managers;
- at the heart of the students’ activation process the motivation for practical and mental activity is laid, without which there is no progress in mastering knowledge, skills, competencies, in their subsequent practical implementation [17,18,21,22]. The method of active learning "brainstorming",
strategies "problems mosaic" and "IDEAL" shows the greatest efficiency in improving the quality of knowledge and increasing the level of competences. In technical education, the application of the project method forms the greatest degree of independence development, systemic and critical thinking. Great attention is drawn to the use of the technology portfolio in the SIW, which shows the strengths of the student and, thus, meets the requirements of the competitive market environment.

It should be noted that the organization of the SIW through the use of the arsenal of training strategies allows determining the main risks of this educational process. The reasons that reduce the effectiveness of the SIW are the breakdown of the contents of the SIW with the new goals of education - the formation of competencies, the formalization of the contents of the SIW without taking into account the individual characteristics of the student.

A competent combination and use of active and interactive forms and methods during the SIW makes it possible to make the educational process not only interesting (for all participants of the educational process), but also effective. At the same time, the level of cognitive activity increases, the acquired knowledge and competencies are flexible, critical thinking develops and the ability to make creative non-standard solutions is formed. Information flows between the participants are of a bilateral nature, since they are based on the conversational interaction of subjects of the educational process.

2. Conclusion
In conclusion, it can be stated that the SIW in the context of the practice-oriented focus should be considered as a source, subject and means of cognition, contributing to the development of internal motivation for learning and teaching, and creating conditions for the realization of cognitive search, self-expression and self-actualization in a specific form of professional activity, and the requests of all participants of the educational process.

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