Pedagogical Aspects of Forming Students' Technical Thinking

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Abstract

Forming students' technical thinking has its influence on professional activity of specialists working in any technological process because it is necessary for proper understanding of technical documentation, standards and norms used in the field. It is important to form technical thinking of future professionals when they have just started to learn their profession as it would help them to master their skills and use the experience in further practical work. This paper deals with pedagogical aspects of forming students' technical thinking during their studies at modern academic institutions. It is focused on especial features in forming such technical thinking related to the future professional activity of students. These features should form a basis for methodological aspects in educational process in teaching technical subject in universities. Analysis of different methodologies of forming technical thinking carried out by the authors demonstrates that well developed technical thinking allows effective solution of now-standard situations in professional activity of modern engineers.

Keywords: technical thinking, professional activity, professional education, technical subjects.

Introduction

Social and economical processes taking place most countries during the last years create a necessity of modification in the teaching process at universities aimed at improving its affectivity. Future professionals should be able to apply their knowledge to different directions and aspects in the field of their expertise according to the requirements of modern technologies, approaches, tendencies,

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etc. These points form a new level of professional education of such specialist based on non-traditional approaches to teaching [4; 5].

Following Kudriavtsev [5], the change of the technical labor contents and character yields the following two main consequences:

- intellectualization of labor functions of people and
- necessity of personal creative abilities' development.

That is why the problem "man and technique" is one of the most actual psychologist problems for of the modern scientific – technical revolution. Its subsequent working-out should be followed by deep analysis of technical thinking and its qualitative characteristics. At the same time it is necessary to base scientifically and test experimentally the diagnostic methods.

An interesting problem is comparison of technical, literary and mathematical thinking specificity. By the operative search conditions a person learns to find and solve technical contradictions, masters the search methods. Thus the investigation of technical thinking gives the psychology and boundless the field for activity by its theoretical and experimental study [5].

As technical solutions and technologies are constantly developed, modern specialists should hive high intellect, fundamental knowledge and proper technical experience. During professional education students can reach not just the declared knowledge about "what", but also to learn "how" [6]. Professional features of engineers include knowledge and experience that characterize the level of their technical and practical competence. Modern industry requires constant adaptation of the technical education system aimed at increasing the role of future specialists in application of innovative ideas in different fields of engineering. This adaptation includes finding the most appropriate approach allowing developing of technical education according to new technologies and social conditions of the society.

It was shown by other researchers that for good understanding of any knowledge by the student their future professional activity should be taken into account during planning the educational process [7]. It is necessary to consider all main kinds of activities related to applications of their knowledge for solving tasks corresponding to the aim of the education [6].

Problems related to technical thinking forming were studied by many researchers [8]. It was shown that such thinking is oriented on understanding technical and technological processes as well as learning the relations between them [11]. This thinking may be characterized by flexibility, fast solutions keeping, active finding of special solutions for non-standard technical problems [13]. A person with good developed technical thinking usually has a system of general knowledge, experience and skills as well as understanding of technical relations between the structure, its details and their special functions [3, 6].

As known, forming of technical thinking is related to learning knowledge and technical activity as well as ability to find principal and new solutions of engineering problems [8]. Necessity of technical thinking appears during participation of students in industrial practical studies, when the students are faced with new problems, non-standard situations and principally new directions in their technical activity.

Technical thinking doesn't provide special logical means for finding appropriate solutions. It is carried out using known thinking operations as analysis, synthesis, generalization, abstracting, systematization, etc [6]. A specific feature of technical thinking is in its context, psychological, but not in formal and operational structure [13].

The most important issues in forming proper technical thinking of students is creating a sufficient background for solving non-standard engineering problems and finding intelligent solutions.

3. Aim and Scope

The current study is aimed at investigation of forming students' technical thinking. Traditional approach to this problem at the universities doesn't always provide solution of all pedagogical tasks. Technical thinking of students becomes evident in non-standard situations, requiring novelty, unique and original thinking. Hence for forming of such thinking it is necessary to develop technical abilities through developing of thinking. This is why different methodological for forming technical thinking is analyzed in this paper.

It is reasonable to put attention to the fact that abilities of students became evident in real definite activities. Moreover these abilities are also developed in these activities. To learn the positive conditions for developing technical abilities of students it is logically to consider the activity related to their future professional. It should be mentioned that the most progressive features in technical abilities are technical thinking and 3D imagination. Technical thinking is formed during independent solution of real industrial problems or in the frame of technical activity.

The current study analyses various technical activities of students and discusses existing methodologies for creating motivation for progressive solutions during their further employment as engineers.

4. Methodologies for developing technical thinking

As known, different specialties at industrial enterprises yield various kinds of technical activities. In the most common case they may be grouped as using and repairing technical objects, their design, production, developing according to modern requirements of the industry. Intellectual component of technical thinking in these cases has on advantage compared to other components and it is related to the specific kind of technical activity.

The above mentioned groups of technical activity have their reflection in forming technical thinking of students, because a complex of technical processes may bring them to brain operations and results, creating solutions required for tasks in their future professional activity.

Peculiarity of technical thinking is in strong relation with technical objects and figurative components of activity. Finding a paper solution for most technical problems is impossible without interaction between objects and imagination. Hence a special attention in the frame of teaching oriented on understanding industrial and technical experience and skills is put to schemes, graphs, drawings, etc.

By solving most technical tasks the students should transfer the information given in graphical representation into selected components of thinking. However, sometimes it is necessary to perform an inverse transformation of figurative thinking processes components into graphical representation

in a form of drawing, scheme of the object or some graph. Such specific of brain activity including flexible transformations from reflections of objects to their graphical representation and vice versa creates and forms technical thinking of future professionals.

The brain activity structure has a strong relation to a system of technical objects. In the design process and during the lifetime of certain technical objects the purpose of the objects' usage is the main aim of the person's activity. In other words it is possible to say that a main characteristic of a technical object as its purpose is also a main component of person's activity and its aim. Solving technical tasks is always related to reflections of other systematic characteristics of the object, understanding of the way its purpose is achieved. The above mentioned processes help to form technical thinking of students.

During technical thinking formation it is important to consider the peculiarities of teaching process in academic institutions, like unity of theoretical and practical activity components, relations between thinking and practical activities. Technical solution of different tasks should be checked practically. Technical thinking is formed in a process of learning technical conceptions and practical actions.

Based on the above mentioned facts, it is possible to conclude that for successful technical activity not just some technical knowledge, skills and know how are required, but also a good developed technical thinking, ability to imagine the object as a dynamic system with a definite purpose, understanding of its practical good in future activity are necessary. It can be achieved by understanding of main definitions, processes and phenomena in technical activity in academic institutions.

Formation of the students' technical thinking includes:

- mastering the system of concepts, phenomena and processes in the fields of engineering, based on knowledge, skills and experience of technical work;
- ability to analyze, synthesize, compare, classify, organize, synthesize;
- developing productivity of thinking;
- ability to apply the extracted knowledge and skills in technical activity.

Previous studies show that formation of technical thinking is based on cognitive development of students' interests [5; 6]. Cognitive interest in its general definition is a selective focus of a personality on the object and phenomena of reality. It is characterized by a constant tendency to learning process, to new, more complete and deep knowledge. To form such interest to studying, teachers can tell students, for example, about the introduction of production in mechanical systems embracing the whole technical process, starting from getting work pieces of their parts and up to testing of final products. Additionally, the means of cognitive interests include solutions of technical tasks the students solve in the frame of their classes at universities. It plays an important role in professional formation of future professionals. Using such tasks promotes learning and qualitative function of knowledge as well as forms students' abilities to analyze, compare, systematize, categorize, synthesize and generalize [5]. The above mentioned mental operations help to form technical thinking.

Although thinking and task solving are closely related each to other, they cannot be identified, because thinking is not only the process of solving tasks. Thinking activity is necessary for learning, understanding of drawings, diagrams, graphs, etc. However, technical thinking is best formed in the process of solving technical tasks, when a student faces some problems, questions, problem situations and solves them on his or her own [4; 11].

It should be noted that creative teaching and technical activity of students is impossible without the development of deep cognitive interest to the object of work. In other words, interest is an important motivation and it stimulates students' educational and working activity, especially in solving technical tasks. It is significant to choose such tasks that could be solved just using the knowledge of technical sciences in general, or using a certain algorithm of working activity. By this approach teacher's activity should be directed to a student as an "investigator", who has to face questions and problems of future professional activities. Such actions will effectively contribute to the formation of the students' technical thinking in higher educational institutions.

Technical thinking will reach a creative, productive level in situations when new goals appear and the old ways and action means are not adequate. The need in productive technical thinking

disappears in cases when a student has mastered a new way in some actions, but according to the traditional approach the student is forced to do known types of tasks and actions. In this case, formation of technical thinking requires from the student to analyze the task independently, identify its most essential components and compile the result.

In view of the foregoing, it is important to emphasize that synthesis of essential characteristics, usage of the known ways of action in new conditions play an important role in creative technical thinking formation. One of the factors required in order to transfer knowledge from one situation to another is a change in the conditions of a new task. For mental activity such change creates favorable conditions because a student can independently analyze, synthesize, specify, evaluate a technical object or process. Additionally, task variability (possibility of multiple solutions) as well as creating conditions for design, selecting the most appropriate and optimal variants in these conditions also require from the students to analyze, make appropriate technical calculations, evaluate the real conditions in terms of the proposed variants effectiveness, choosing the optimal parameters, summarize, precise, etc.

The tasks of technical content can be categorized as follows:

- a task for generalization and specification of technical material;
- a task for projection;
- a task for design;
- a task for the establishment of technical diagnostics;
- a task for the operation of spatial images and relations.

Definitely, these tasks can be used at different stages of learning and cognitive activity at universities, academic institutes and colleges. In the process of new material assimilation the tasks solutions stimulate the students' need for new knowledge, contributes to formation of independent methods of programmatic issues analysis. At the knowledge reinforcement stage the students master the means of their practical application.

To solve problem of technical tasks include a wide range of technical issues related to the structure of machines and mechanisms, technological processes, design principles, technical

terminology, etc. Really, innovation and invention as well as creativity of future specialists in their future work are possible only if proper ways for solving technical tasks are formed during students' education and desired level of technical thinking is achieved.

It is appropriate to focus on how the technical thinking is formed in the process of the technical tasks solving. Undoubtedly, in the process of technical tasks elaboration there is a need to take into account modern scientific achievements concerning the new ways for processing and manufacturing of parts, devices and mechanisms, new materials utilization, means of mechanization and automation of modern manufacture, etc. The results obtained in the process of solving the tasks of technical content, should provide answers to production issues and increase technical background of future specialists. Formation of students' technical thinking includes the development and unity of theoretical and practical activity components, continuous combination and interaction of cognitive, educational and practical actions.

Conclusions

The foregoing arguments make it possible to assert that the solution of such tasks directs students to determine the optimal parameters of a technical object, teaches self-selection, helps to realize the multi-versions of most technical tasks that may appear in the future. All this contributes to the formation of students' technical thinking.

Summarizing, it should be underlined that if constantly strive to form the technical thinking of students in classes at academic educational institutions, then certainly in the future, they will be able to formulate tasks by themselves, choose and make the required schemes, carry out calculations for different parts, design, analyze the results, make appropriate conclusions, specifications, etc.

The current study has examined just selected aspects contributing to formation of students' technical thinking at academic institutions. These features of the technical thinking determine the methodological techniques and cognitive activity in the frame of teaching technical subjects at universities, academic colleges and institutes.

Further research is needed to develop the system of technical tasks having effect on students' psychological activity in order to speed up learning, to increase independence, to master activity methods, to develop the ability to view the problems – that is the ability to move together with accelerating scientific progress.

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