SCIENTIFIC THINKING FORMATION AS A FACTOR OF THE EFFECTIVE TRAINING OF A MODERN SPECIALIST

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Abstract

Modern education requires the formation of high professional competence, an integral part of which is scientific thinking. However, universities sometimes fail to develop it. In modern Europe, the slogan of "practically oriented education" is widespread. At the same time, the "theoretically oriented education", which should shape scientific thinking of future specialists, is underestimated. That is why it will be reduced to "practically oriented thinking". There is underestimation of fundamental science in solving specific practical problems in non-standard situations of changing circumstances.

An integral part of scientific thinking is prognostic, perspective thinking, able to see the variability, multiplicity of possible options, as well as to anticipate the consequences of certain actions. This is especially important in planning, design and management.

In the modern world, the simplified interaction between scientific and practical thinking often prevails. This means that the practice is carried out in isolation from the theory or relies on the scientific analysis of only one science (e.g. economics, law).

Scientific thinking can be formed when communicating with the scientific community. The closest to the student representatives of the scientific community are their teachers. Taking into account the significance of independent work of students, teachers are an important link in the formation of scientific thinking. The teacher's scientific language is of the utmost importance. The language of science in the analysis of complex problems should not be simplified. Without of a complex scientific language it is impossible to reveal scientific ideas.

The way students think is an element of their professional consciousness, a special quality of the mind, which is formed on the basis of fundamental theoretical knowledge. Scientific thinking enriches the accumulated knowledge, skills, abilities and forms the creative intellect of a specialist.

Key words: *scientific thinking, practically oriented education, theoretically oriented education, university, theoretical knowledge, education, students´ activity*

The modern world is on the threshold of the fourth industrial revolution when scientific knowledge and thinking become the key factors of social progress. The future will lie with that society that has no alternative but to develop knowledge and enlightenment and that considers cognitive/theoretical knowledge as a mandatory space of science [1] Mohr, (2008).

A university is one of fundamental social institutes of modern society and its major function is to produce knowledge. A university's educational activity stipulates the transfer of experience in using scientific methods and forming scientific thinking. The degree to which it fulfills this function will determine the society's knowledge level, because a scientific method not only provides knowledge increment but ensures a scientific level of practice.

The person receiving a university degree must be able to digest scientific knowledge and transfer it in the process of real practical activity. The person who obtains the experience of university education is usually believed to master the skills of different cognition methods, namely scientific ones, and consequently, a special way of thinking, specifically a scientific one. However, sometimes, universities fail to effectively carry out the task of forming their students' scientific thinking. In modern Europe there is a widespread slogan of "practically oriented education". It is common knowledge that the scientific component of a specialty is nowadays also underestimated by students –

"generally, they look at education as a tool – it is not a goal in itself but a means to land a good job at the marketplace" [2] Semenova, (2010, p.298).

Scientific thinking, therefore, is perceived as a competence required mainly in scientific work. "The importance of practical experience in higher education has been long emphasized and consistently considered as a crucial requirement. Fears that university education does not sufficiently prepare for practice, because science is very theoretically oriented, have been brought up for more than 30 years ». [3] Multrus, (2012, S.9) The question then arises, to what degree does a university have to fulfill the task of forming students' scientific thinking and which factors influence this process? Within this framework, *theoretically oriented* education, which is supposed to form scientific thinking in future specialists and by its content to provide deep understanding of the core of problems, particularly in non-standard situations, is considerably underrated. In the absence of theoretically oriented education, "practically oriented" students' thinking is formed in close relation to practical usability of knowledge in an individual's activity, while any other objects of reality not connected with the specific, just practical aspect, are beyond their thinking space. Hence, in this case we can talk about the reduction in understanding the properties and essence of objects of reality in practical thinking, especially in non-standard situations of quickly changing circumstances. Very often, in routine oft-recurring practice there happens a similar process - the decrease in scientific thinking components obtained at a university down to the level of commonplace thinking, forgetting of scientific notions or just underestimation of science in solving specific practical problems.

Why is "practically oriented" thinking thought of as approved and more widespread practice when compared with scientific thinking? The answer might be as follows: it is the simplest technique to achieve some results. Practical thinking constrained by any concrete task is a tool aimed at a relatively simple explanation (interpretation) of reality. Consequently, the process of practically oriented thinking is simpler, i.e. it requires lesser intellectual exertions and knowledge. A practically oriented individual doesn't bother himself to ask questions what is "real" for him and what he knows until he meets this or that practical challenge. He/she orients himself to everyday needs and takes his "reality" and his "knowledge" for granted. It does not necessarily mean that practically oriented thinking is always ineffective. Based on experience, it yields positive results in recurring standard situations. We are not against practical knowledge, we are against absolutization of practical orientation in the teaching process. However, as soon as a non-standard, unexpected situation happens, practical (empirical) thinking often becomes powerless. The obtained knowledge, no matter how extensive it is, can't be effectively used in practice. Moreover, it is worth noting that knowledge and thinking do not correlate completely. Knowledge, as a set of notions, facts and even experience learnt, is *statics of consciousness*, while thinking is a competence to see *dynamics and logic of relations* in reality.

At the same time, scientific thinking enables to develop objects so that they are capable of expanding the boundaries of practical experience. Scientific thinking means that an individual can act efficiently on the basis of abstract, and, therefore, versatile models in any setting within the framework of his/her profession. Indeed, a scientific thinking model is abstract but it allows to create an image (construct) of perception reflecting a logical *relationship and essence of real objects* and providing a rational process of an individual's atypical creative practical activity. Thus, abstractedness of scientific thinking "does not imply that in everyday life or science we are unable to comprehend the reality of the world. It implies that we perceive only some of its aspects, namely those which are relevant for us both to do things in our life and from the viewpoint of accepted procedural rules of thinking called a scientific method" [4] Shutz (2004, p8). Berger P. and Lukman T. share the phenomenologist A. Shchutz's opinion that "theoretical definitions of reality, whether they are scientific, philosophical or even mythological ones, do not cover all things that are "real" for the members of the society [5] Berger P. and Lukman T.(1995, p.14)

We believe that professional reality is determined not just by the experience of real events facing an individual but by the experience serving as a reality-learning style, i.e. the type of thinking used by him/her in order to improve his competence and professional knowledge. Facts and processes in practice are always interpreted as the facts selected from the situational context by means of abstractive activity. The quality of interpretation often depends on a specialist's knowledge base where

theory plays an essential role. 1. Interestingly, but it should be emphasized that interpretation depends on understanding. Understanding is one of the most important problems facing both science and practice in modern society when huge streams of information fall on an individual and demand adequate reflection and understanding. Today's world requires understanding not only in scientific thinking but in the solution of various practical problems as well. Inadequateness of understanding the reality facing various problems can be observed throughout the history of human development. This challenge takes a turn for the worse in modern society. Crises in public life lead to breaks of old relationships, a crisis state of consciousness and psychology lagging far behind the changes results in inadequate perception of social reality. "What is more, under the conditions of developing modern means of communication and information and their high availability, there is a danger of developing the so-called "cognitive traps" not only for some individuals and groups but on a macrosocial level as well" [6] Sivirinov (2002, p.75).

In all its relevance, the understanding phenomenon can't minimize the significance of scientific/theoretical knowledge just because understanding is the result of scientific analytical thinking. Certainly, we are dealing here with scientific understanding as a specific sustainable cognitive process, which normalizes and rationalizes the information of diverse professional space. In this connection it should be underlined that in real life there often occurs an illusion of understanding. It is particularly true for social processes. It is a paradox that illusory, erroneous or incomplete understanding of historical, political, economic processes is encountered not only in social practice but in social sciences as well. It can be explained by a specificity of the society as a complex system. When teaching social disciplines, focus should be placed on this side. The level and adequacy of understanding are related to the phenomenon of rationality in the cognitive space of consciousness. In social sciences "social rationality is a function of activity both of an individual and social formations with regard to social reality … Of major importance here are the degree and methods of adequate perception of both the social environment and the social subjects' personal activity" [7] (Sivirinov 2003). The American scientist A. Etzioni classifies rationality as "subjective", when a person orients himself to subjective perception, and "objective", which is scientifically recognized as the best [8] Etzioni(1975, S.275).

In the teaching process, understanding should be first of all on hand in reading scientific tests. It is the primary training of a future specialist's scientific consciousness when studying meaningful and insight aspects of professional activity described in scientific literature. While reading the texts of theoretical articles, students have to learn how to properly interpret, from the science standpoint, their content and, consequently, understand them. However, it should be emphasized that understanding of the underlying causes of the problems in a text is frequently a challenging task, if one fails to relate them to a wide range of practice, which is objectively more complicated than interpretation models in its sociocultural space.

It should be taken into account that scientific thinking is not only related to current practical activity but it allows for presenting those fragments of reality that might become a subject of practical development in future practice. It means that *prospective prognostic thinking* is an essential integral part of scientific (theoretical) thinking. *Perspective thinking* implies a certain state of consciousness producing practical and vital images of the future. These images should reflect not only the state but a movement towards the specific state of a certain system (technical, biological, social) and ambient environment as well. Another important quality of perspective thinking is its ability to see variability, i.e. multiplicity of images of possible options of the future, as well as to analyze and prognosticate the *consequences* (results) of various actions. And that is particularly important in the spheres of planning, research and development and management.

Routine business practice induces a specialist to orient to this or that state of the situation, possible behavior of the competitors, so that to respond and achieve the required outcome on time. This business dynamics, in its turn, revitalizes the images of the future in the form of a generalized mental image of "*social quasi-reality*" [9] (Sivirinov 2003), of the future which serves or is taken into account as the base for making decisions on a prognostic model of the business situation.

The richer and more vivid an administrator's, manager's or any leader's imagination, the higher the probability that he would take adequate and correct actions. Thus, developed futuroreflection, or "prospective thinking" is a crucial quality of not only a leader but of every doer as well.

Prediction is a crucial element of the scientific approach in any type of activity. In modern scientific knowledge there is a considerable number of prediction methods. Each method has its own specificity and differs in designation, type of prediction/analytical information and procedures of determining predictive assessment parameters. It should be emphasized that despite the available prediction methods, there is a wide gap between the predictive methodology offered and the extent of its application in practice. One of the reasons is insufficient training of specialists who are unable to use prediction techniques while solving specific professional problems. Of course, a student is not bound to master all prediction methods within the framework of professional knowledge and skills, but every specialist must learn a routine method of extrapolation. A cognitive base of the extrapolation method is forward reflection. The content of forward reflection is the image of a future situation or state to appear as a natural development of conditions and circumstances. Therefore, in teaching various disciplines, the trainings and tasks on developing this forward reflection will facilitate acquisition of the extrapolation method. When teaching extrapolation prediction methods, it is of primary importance to draw the students' attention to such basic concepts as trends, trend estimation, time series analysis. In modern practice of extrapolation prediction, quantitative variables are most commonly used. However, the extrapolation method can yield qualitative indicators as well by means of expert analysis. Teaching how to select experts and to organize expert prediction is an essential element in the formation of predictive scientific thinking. Teaching the art of creating predictive scenarios, scientific assessments and learning the methods of taking into account the experts' opinion while developing predictive scenarios present a useful experience, which will improve the efficacy of every specialist's work.

Modern academic education suggests the development of various abilities related to scientific thinking: "ability to precisely and meticulously perceive and process information, ability to use lateral networked thinking, ability to understand complex interrelationships of structures, principles and patterns" [10] (Pasternack et al.2006). The overarching component of scientific thinking is *system thinking*. Any person living in a society already has system thinking. But very often it is commonplace, simplified thinking based on his/her personal experience only. «Scientific thinking is something people *do*, not something they *have*. The latter we will refer to as scientific understanding. When conditions are favorable, the process of scientific thinking may lead to scientific understanding as its product». [11] (Kuhn 2010).

p. 2.] Therefore, a favorable condition for scientific system thinking, first of all, is education. Every educated, competent and experienced specialist is a person who possesses professional system thinking. Scientific system thinking implies sophisticated and most adequate perception and understanding of the reality which is systemic by its functional nature. "System thinking is an approach that enables us to see and understand the essence and pattern in the observed sequences – patterns of the events, so that it will be possible for us to prepare for the future and to influence it to some extent. It means that we shall be able to manage the situation in some sense. » [12] O'Connor and McDermott (2006)

During the formation of scientific system thinking in the teaching process, it is necessary to give students some tasks on structuring the objects and identifying their system elements. Of great importance in system thinking is the ability to see not only the system elements but to correctly determine and understand the relationships and interactions inside these systems including their functional significance. Science has elaborated relatively effective methods of systems identification and management in engineering and nature, but in social sciences, however, these methods are still underway. It should be noted that in sociology, economics, politics and social sciences, a major problem is adequate perception of social reality systems.

The danger of erratic illusory perception of systems phenomena and processes in a society "is related, firstly, with clarification of to what extent the system consideration of social objects would allow for understanding their complexity and diversity and providing their sequence and manageability, and

secondly, to what degree a system approach enables us to see "real", "objective" structures or their manifestations » [13] (Sivirinov(2002, p. 124). In practice, people are restricted in their ability to perceive the systems world, which is richer and more sophisticated in its reality. As D. Baecker notes "systems seem to suggest that there is more order and reason in the world than any of us is ready to admit and able to account for" [14] Baecker (2001). Therefore, there is a challenge to teach students to use system thinking to perceive complex and ordered objects and processes in professional reality, to form their *adequate* understanding and to create adequate models of practical activity on that basis.

In modern world scientific and practical thinking interact on a reduced, simplified basis. It means that practice is implemented based at best on the scientific analysis of just one science. For instance, in the field of law the lawyers do their analysis within the framework of legal science, the economists – within the framework of economics. On the outside, it looks logical. However, one should bear in mind that *disciplinary localization* does not apply to real practice. A scientific approach demonstrates and proves that, for example, the problems of law and economics can't be solved without other spheres of society (social, political, cultural, demographic). Genuine scientific thinking is able to see a complex nature of problems and to involve the entire set of sciences needed in each practical setting to solve them. *Polymorphism of practice* also requires *polymorphism of knowledge* as crucial interdisciplinary erudition to be found in all specialists.

Interdisciplinarity when teaching a specific specialist implies the formation of restricted professional thinking in combination with general scientific erudition in other disciplines needed to fully understand the functional unity of polymorphic processes in practice. "Interdisciplinarity means joint work of specialists studying all possible aspects of a general (single) problem. In doing so, each specialist draws upon his/her own methodological disciplinary base" [15] (Kushhina 2013).

It should be noted that interdisciplinarity is primarily understood as a principle of practice. In an advanced form, it may exist as a consequence of interdisciplinary professional education. Interdisciplinarity in education facilitates the expansion of a professional knowledge frame and becomes an essential component of professional competence. Interdisciplinary thinking should be taught, so that students could study each specific discipline in the context of other required disciplines. It is necessary to emphasize that interdisciplinary thinking, as a rule, is not able to build up professional encyclopedism. A student should not be a specialist in all areas of knowledge. However, he/she should be interdisciplinarily trained, so as to organize interdisciplinary practice and to understand what specialists in different academic disciplines should be involved to carry out a correct analysis of situations and processes and then to use this analysis in "interdisciplinary" practice.

The growing role of fundamental knowledge is becoming a basic component of the teaching process. Modern technological progress makes it possible to turn this knowledge in a guideline to follow both in science and practice. When treating education in a pragmatic way, theoretical knowledge seems to be excessive. "However, on taking such a narrow pragmatic (or as theoreticians of a competency-based approach like to say, practice oriented) approach, we will inevitably become victims of current needs". [16] Andreyev, (2011, p. 181-182)

Modern scientific thinking as never before implies the interaction of theoretical content with no less deep knowledge of practice. The logic of information/technological progress with its robotization and automation *leads to an ever-greater value of human activity intellectualization.* Thus, scientific thinking should be formed in the context of practice, while practice in the context of scientific knowledge.

While discussing the role of scientific thinking in the context of practice, it is worth noting the crucial importance of scientific thinking and its cognitive mechanism in scientific activity. Scientists are known to follow master's and doctoral courses. Frequently, a traditional section relating to scientific/theoretical significance of the research in a thesis is weakly highlighted. Many theses are predominantly of empirical nature, where the theoretical part is presented in a superficial manner, while the practical importance is prioritized. In my opinion, every thesis, primarily a scientific treatise should contain a well-thought-out theoretical section based on fundamental science. It should be kept

in mind that it is fundamental theoretical knowledge that facilitates the development of science and innovative practice.

What is needed to form students' scientific thinking? It should be underlined that scientific thinking can be formed and reproduced only in the system of relations with the scientific community. European scholars emphasize the importance of education "through science" [17] Tremp and Eugster (2013). In modern world the experience is no longer considered as an independent pure knowledge source, [18] (Fleck 1981.) and the transition to greater abstractedness is thought of as a natural stage in the development of fundamental education [19] (Franklin 2013).

The closest to a student representative of the scientific society is a teacher. Thus, one of the conditions of a goal-oriented activity, as a form of scientific thinking implementation, is group communication resulting in intensive interaction of students and teachers-scientists and leading to a possible scientific dialogue in the teaching process. Involvement of students in research work to a large extent depends on the quality of theoretical training and scientific activity of teachers themselves. Giving the importance of students' independent work its due, we believe that teachers are the key factor in forming scientific thinking and producing scientific knowledge. As a creative personality, a teacher can and must use "a diverse range of approaches and organizational forms, methods and teaching means" [20] (Popova 2013). In the teaching process a teacher performs a regulating and correcting function. He/she puts questions, evaluates students' statements, strives to provide understanding of the material under study. It is often said that a teacher's scientific language should be simple and plain for students. However, the language of science when analyzing complex problems shouldn't be simplified and primitive. Many notions and categories can be explained by means of a sophisticated scientific language only. Plainness at the expense of scientificity would hinder the students from building a habit to understand complex scientific texts. In this connection it is important to recommend that students read theoretical texts, especially those written by theoreticians in any science.

At a university with the eminence given to goal-oriented actions one can find the processes of intensive communication expressed in teacher-to-teacher or teacher-to-student dialogues taking place during workshops and lectures. The students engaged in teaching discussions and disputes are able to formulate their own point of view on some object or professional activity process and to manifest interest in the use of theoretical knowledge in practice.

So, scientific thinking can exist only in goal-oriented rational interactions. Low intensiveness of communication with the teachers often leads to a shortage of students of higher educational institutions who are eager to engage in discussions or dialogues, thus resulting in a teacher's monologue and students' inactivity. Of primary importance is the type of thinking which dominates in students' groups, as well as how these types interact in the teaching process. A student with scientific thinking strives to demonstrate it in the teaching process, research, oral presentations at conferences and workshops. Independent writing of articles and publication activity do facilitate the formation of students' scientific thinking.

The teaching process at a higher educational institution suggests communication of diverse participants, whose actions are accompanied by different levels of perception of interaction necessity, i.e. different levels of reflection concerning the goals and means to achieve them. In other words, an individual aspires to turn scientific knowledge in a product in the value exchange system. We believe that while combining two types of thinking (scientific/theoretical and practical) in a student group during the teaching process, we have to support a joint activity of students actively engaged in theoretical discussions with teachers and those with a practical/pragmatic type of thinking. Frank Fischer notes that the phenomenon of scientific thinking and argumentation is considered in learning science as three types of teaching procedures: "(1) scientific discovery, (2) scientific argumentation and (3) understanding of the nature of science" [21](Frank Fisher). It may be deduced that scientific work is operationalization of theoretical models of practice aimed at gaining new knowledge, applying them to the real objects under observation. Thus, students' participation in research enables them to watch a living embodiment of theory in practice.

In this connection, it may be concluded that in modern times, experience is no longer considered as an independent pure source of knowledge. The transition to greater abstractedness is a natural stage in the development of fundamental education [22]Franklin A and methodological culture of thinking [23] Medvedev, V 2010].

Mastering a scientific paradigm of thinking develops specific abilities of a subject of practical activity. While acquiring scientific means and methods, students also get command of a certain system of value-based orientations and goal settings typical for every type of practice. These orientations should stimulate the scientific content of practical activity. Thus, one more important process emerges, which in the forthcoming decades will devolve power in current practice, in implementation of routine tasks and functions to automatic machines and robots. *Therefore, there will be a greater demand for human beings in the sphere of creative, scientific and designing activities based on fundamental theoretical knowledge that the new generation should master right now.*

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