УДК 378.1

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MATHEMATICAL LANGUAGE AT TECHNICAL UNIVERSITY

***Abstract**: In the article is analyzed philosophical and mathematical engineering aspect of intended use of mathematical language in higher technical education at the present stage of its development, based on the characteristics of the mathematical language in didactic space*
of technical university. Considered a problem of low skills in mathematical language of the students, and as a consequence – development of mathematical speech. Offered possible areas of improvement of mathematical language mastering by the students during professional training based on deepening application of functions of mathematical language (communication, idea forming, epistemological, integrating, nominative, information-preserving, culture bearing) in the educational process.

***Keywords**: mathematical language, mathematical speech, mathematical language functions, mathematical culture of engineering students, professional training, technical university.*

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МАТЕМАТИЧНА МОВА В ТЕХНІЧНОМУ УНІВЕРСИТЕТІ

Анотація: *У статті проаналізовано філософський та інженерний аспект призначення математичної мови у вищій технічній освіті на сучасному етапі її розвитку, спираючись на особливості математичної мови у дидактичному просторі технічного університету.*

Розглянуто проблему недостатнього рівня володіння студентами математичною мовою, і, як наслідок, – розвитку математичного мовлення. Запропоновано можливі напрями удосконалення засвоєння математичної мови студентами у ході професійної підготовки на підґрунті цілеспрямованого поглиблення застосування функцій математичної мови (комунікаційної, мислеутворювальної, гносеологічної, інтегруючої, номінативної, інформаційно-зберігаючої, культуроносної) у навчальному процесі.

Ключові слова: *математична мова, математичне мовлення, функції математичної мови, математична культура інженера, студенти, професійна підготовка, технічний університет.*

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МАТЕМАТИЧЕСКИЙ ЯЗЫК В ТЕХНИЧЕСКОМ УНИВЕРСИТЕТЕ

Аннотация: *В статье проанализированы философский и инженерный аспект предназначения математического языка в высшем техническом образовании на современном этапе его развития, опираясь на особенности математического языка в дидактическом пространстве технического университета. Рассмотрена проблема недостаточного уровня владения студентами математическим языком, и, как следствие, – развитие математической речи. Предложены возможные направления совершенствования освоения математического языка студентами в ходе профессиональной подготовки на основе целенаправленного углубления применения функций математического языка (коммуникативной, мыслеобразующей, гносеологической, интегрирующей, номинативной, информационно-сохраняющей, культуронесущей) в учебном процессе.*

Ключевые слова: *математический язык, математическая речь, функции математического языка, математическая культура инженера, студенты, профессиональная подготовка, технический университет.*

Problem setting. Changes in social relations actively influencing education, requiring from it adequate response to the challenges that it faces at each stage of development. In connection with the total computerization increased communication capabilities, including engineering. In such circumstances, status of mathematical language is determined by its global application in science and technology and in other fields of human activity. So, before the higher technical educational institutions there is a problem in-depth study of mathematical language by students and also developing their mathematical speech to ensure future communications of engineering staff at modern professionally required level.

Recent research and publications analysis. Performed analysis of the latest scientific work leads to the conclusion that certain issues of studied problem were considered by N. A. Vavrenchuk [1] I. S. Vasyunyk [2], T. L. Godovanyuk [3], I. I. Kuleshova [8],

D. V. Sharmin [12] and others. First, there is very little scientific research on mastery of mathematical language and the formation of mathematical speech in recent years, appears concern about the interest of scientists to psychological and educational problems of exact sciences, and secondly, most of the work concerning education in high school or future teachers of mathematics. Definitely positive is the fact that the psychological and educational research functions of mathematical language and speech unites commitment to providing high quality mathematics education in general and successful execution of professional tasks in future. However, depending on the fact, that mathematical language is used in the teaching of almost all engineering disciplines, is actively used in the formation of interdisciplinary connections, possession of it promotes the professional orientation of subjects of education to apply mathematical methods in solving practical content, authors believe that not enough attention is paid to methods relating to the in-depth mastery of mathematical language by the students of technical universities and also invention of ways to improve mathematical speech by the subjects of education.

Paper objective is the theoretical justification of possible areas of improvement of mastering mathematical language by the students in the course of professional engineering training through a targeted deepening of use of the mathematical language functions.

Paper main body. Scientific knowledge is described by a large number of languages. But mathematical language as a component of mathematical culture has a powerful capability of converting of the recorded information on it. Mathematical language is an effective way to create mathematical models and logical constructs during any engineering activity.

Mathematical language is not only commonly used universal language of modern science, but also the common language of communication, which has national and regional borders. Therefore, a person using it imposes high demands on the meaningfulness both of his language and another person's language with whom he talks. When using mathematical language there is a need for a clear and understandable expression of personal thoughts, intentions, description of the action, etc. Mathematical language overcomes the awkwardness and removes ambiguities of natural language, expands its applicability.

Mathematics – was and remains an instrument of development of the universe, so it has the structure of modern knowledge of special status. And for engineering education it is a fundamental discipline. Mathematical language is a peculiar way of theoretical description of reality. As noted M. I Zhukov: mathematics is "like a philosophy so it claims to universality. However, unlike philosophy and all other sciences, this area of knowledge is a formal means of describing reality through the use of a particular language. But the artificial language of mathematics is a kind interspersion in natural language, and it assists in a description of reality, underestimation of which means equally dangerous extremes in deciding role of substantive and formal in knowledge" [6].

To clear certainty of further scientific research as a mathematical language we understand – *sustainable for the current period of development mathematical science of common international system of signs, symbols, tools and rules for their use in mathematical space*. This is a phenomenon of global dimension, which is both an instrument and a means of communication to any person who enters the mathematical environment: from child who learns to count to scientist and mathematician. In this sense are talking about the system of German, French, English and any other languages. So, mathematical language actually exists, used for presentation of abstract mathematical ideas and opinions and occupies a special place among the existing languages as a fundamental language of science.

Mathematical speech is a manifestation and operation of mathematical language. Unlike the latter, mathematical speech of everyone who uses it for communication has certain individual features depending on the mastery of language, professional need to take certain terms and means of communication, their own principles and preferences of native speakers and more. Therefore can be argued that this phenomenon is a variable process and mediated by the process of communication. Therefore mathematical speech in didactic area, including higher technical educational institution should be considered from the standpoint of activity theory.

Use of the term "mathematical speech" refers mainly to two cases, namely: 1) as a form of communicative activity of study, ie use of mathematical speech to communicate during the training process and beyond it. In this sense, mathematical speech – is a specific activity, expressed in sound or in writing; 2) as a really existing result of activity – outline of lectures, scientific articles, problem or equations solving, etc.

Since mathematical speech is always used in conjunction of artificial mathematical language and natural one, he is characterized by gradation on the same types, under which is distinguished natural language, namely: *external* and *internal, oral* and *written, monologue* and *dialogic, active* and *passive* [9]. As for external speech, it is usually related to everything visible, heard, delivered in oral or written form. Inner speech is like planning phase in practical and theoretical activity at the stages of reproduction of the plan. In written or sign speech conditions of communication were mediated by the text. Writing speech is more concentrated on the content, than oral, written speech appears later, than oral and formed on its basis. Speech that is heard or pronounced by a person is oral. It may be a monologue and dialogue. In dialogical speech are involved more than two participants. This type of speech, as a rule, supported, is situational, it may not be quite complete, not planned, emotional, that is supported by mutual remarks of the conversation partner, it is not fully deployed. Monologue speech refers to one person: lectures, reports, messages and so on. To make monologue speech is more difficult, than dialogical, its expanded forms in ontogeny are developed later and its formation in students is a particular challenge for high school teachers.

All these types of speech are categorized as active speech. While passive speech occurs when the subject of study does not speak or write, but just listens. Passive speech involves perception and understanding of the language of another subject. This process requires the identification of *linguistic resources*, such as sounds, words, their combination and another, and those thoughts that are reproduced and expressed by these means.

From which place and strategical role is allocated on mathematical language in technical education, from depth of understanding of the nature of the subjects of training depends what function it performs or potentially has. In terms of engineering philosophy of mathematics we are interested in the philosophical interpretation of the function. In philosophical dictionary of Brockhaus-Efron is noted that this feature is "ratio between the two elements at which any change in one meets is a definite change in another" [11, p. 263]. Thus, the definition of the functions can be viewed in terms of the consequences that may be favorable, unfavorable or neutral, caused by a change in one parameter settings in other object – is a manifestation of functionality, or the relationship of the individual parts as part of a whole, that is, in the process of operation of the system [13]. Given the problem of improving mathematical language of students in the process of training category of function is fundamental, therefore, allows methodologically systematically solve the named issue based on structural-functional approach.

Analysing the value of the mathematical language of subjects of education and level of their mathematical language skills N. O. Vavrenchuk notes that the formation of the

aforementioned categories "provides awareness of education, accelerates the development of mathematical thinking as a set of logical operations, capacity for deductive reasoning, thinking, thinking with collapsed structures, rational handling with sign systems of mathematical language, spatial perceptions, memory and imagination. Maximum opening the possibility of human thinking, math and its language is its highest achievement" [1].

Basic and secondary functions that perform mathematical language as a specific phenomenon of human civilization, causing the function of mathematical language, which in its educational, professional and life purpose also has a multifunctional character. Therefore, to distinguish between functions expressed is very difficult because of their close relationship and interpenetration. Concept of *features* (lat. *functio* – implementation, implementation) in the context of the study will consider the appointment and role of mathematical language in higher technical education, as well as performed tasks with mathematical language. It should also be noted that in real didactic process in the mathematical study of functions of mathematical language and speech are manifested in various combinations, often dominated by one of them.

Communication function is the main function. It means use of the mathematical language as a means of communication. While communication is important because it transfers the information on the substance.

Communication function is composed as it, firstly, includes exposure function, ie the ability to provide one person using speech to encourage others to action; secondly, function of communication – exchange of views between people through words, phrases and other aspects.

At the present stage of development of education is particularly important feature of influence concerning, for example, a call to establish contact, ie goal of notification at this function – to establish, extend or terminate the communication. The said feature also allows to check whether the channel is working. This feature, along with the mathematical language has almost all other existing languages, artificial and natural. But the manifestation of this function in relation to mathematical language in today's conditions is unique. Since seeing mathematical statement or proof of some mathematical provisions or original problem solving, sender and recipient can immediately start communicating no matter carriers of which language they are in everyday life and whether they generally understand the language or languages except mathematics, with which they can communicate freely. Modern branching of the Internet allows to see a lot of information and gives the opportunity to instant establish the contact. The paradox is that a large flow of information sometimes prevents start of communication in the scientific community. However, only one formula can be seen impetus for establishing contact, the desire to answer and start talking. Unlike natural language communication, in which contact establishing influence function usually does not carry meaning, in communicating in a mathematical environment the sense is always present.

So at teaching of quite large in terms of the course not only mathematical subjects for future engineers, but also subjects of professional cycle, focusing teachers' attention on accuracy, rigor, common use in writing by the operators, symbols, formulas, mathematical expressions, sentences, etc., affect the speed of setting contacts in professional field and, consequently, provides a high level of communications capabilities throughout further professionally and productive period of life of graduates of technical college.

Idea forming function is performed in the application of mathematical language as a way of thinking. Issues of relation of language and thought were studied as long ago as by Platon [11, p. 281].

Let's note that the mathematical language and mathematical thinking are essential components of mathematical culture of the future engineer. In addition, the language process is closely intertwined with mental process. Given the importance of higher definite relationship and mutual influence, let's consider valuable conclusions of L. S. Rubinstein that "speech is not just the outer shell of thought, which it throws or clothes, without changing its essence. Speech and words serve not only to express, bring out, transfer to another language without a ready mind. In the speech we formulate opinion, but formulating it, we often form it. Speech is more than an instrument of external opinion; it is included in the same process as a form of thought related to its contents. Creating speech form thinking is also formed. Thought and speech, not identifying is included in the unity of the same process. Thinking in speech is not only expressed, but mostly it is performed in it" [10, p. 395].

German philosopher I. Kant, exploring mathematical topical area, insisted on the priority importance of the ability to think and develop the mind to achieve professional competence: "Ability of judgment is a special gift that requires training. Lack of judgment is actually what is called stupidity, and there are no cure of it. Dumb or limited mind, which lacks only the proper power of the mind and own concepts, with the help of learning can achieve even wisdom. So doctor, judge or politician can have in their head so many wonderful medical, legal or political rules that they can be able to be a good teacher in their area, and yet in application of it can easily fall into error because they lack the natural ability of judgment (not knowledge), so though they are capable in abstract to see the general, but can not distinguish if it fits this case in concreto, or because they are not enough prepared for such a statement with examples and real activity" [7, p. 241].

Epistemological function is that mathematics is a powerful tool for knowledge of the world. Scientific research and interpretation of most natural processes in the universe becomes practical value for society and makes it possible to use them for the development of mankind after strict mathematical description. Peak of such studies is to establish the physical, chemical and other laws that are recorded using mathematical language. In this case, the mathematical language also performs an *integrating* function.

It is well known that on the basis of logical analysis first purely abstract, using mathematical tools, appeared some global laws of electricity and magnetism, gravity, radio and others.

Integrating function stems from the objective mathematization of any field of science and technology. The most significant manifestation of integrating functions are widely used in various fields of scientific methods and apparatus of mathematics and formal logic, fixed mathematical language. Unity, integrity and universality of the manifestation of this function is, for example, that using the same type of differential equations can be counted both eddy currents in the final part of the turbogenerator and chemical processes. Integrating function of mathematical language is realized through universal mathematical apparatus as a tool of knowledge, emphasizing the unity of scientific knowledge. Mathematical language is a tool that integrates scientific community around the world, linking people and states.

Nominative function complies with the code, so the subject of the operation is the cod itself. This feature is related to the ability of symbolic language to mark the things symbolically. Ability of mathematical language to semantic-symbolic substitute items, objects, processes or phenomena, together with largely abstraction allow to create perfectly accurate theoretical world, and through such opportunities to explore the actually existing world. It should be noted that the very possibility of knowledge and the development of the world is when it is named. Any language, natural or artificial, is a means of naming all the

objects, attributes, operations, number, around the world, real and unreal entities. This process scientists call lingualization or bespeaking of the world. Consequently, corresponding function can be realized in the statements of the language, lectures, grammar, dictionaries. In academic writings, disparate directories and other sources, this function is shown in mathematical language definitions, characteristics (quality, quantity, characteristics, etc.) of an object or process of research or study, in describing a mathematical model of the object and so on.

Theoretical basis of any discipline of mathematical series is its conceptual apparatus, in turn, learning success is directly dependent on the efficiency of absorption. Following the logic of relationships, based on the above characteristics of nominative function, we obtain the need of hard-depth study of mathematical language and further improvement of mathematical speech of students during training at higher technical school.

Information-retaining function lies in the fact that the existence of mathematical language provides the ability to accumulate and accurate uniquely interpreted transfer of knowledge and achievements of various branches of science and engineering to other people and future generations in the form of written sources, audio recordings and other media. Almost everything known to mankind about the world we know and learns through the language.

Culture bearing function appears because the knowledge of mathematical terms and symbols, close relationship of the work over the forms of language units, implementing mathematical thinking and mathematical language in unity, promotes development of common culture of speech of students, providing awareness and strength of acquiring of knowledge. Improving language and mathematical language is necessary but not sufficient requirement for the development of mathematical thinking and, consequently, formation of mathematical culture of students. Exploring mathematical culture of students of technical high schools, I. I. Kuleshova offers under mathematical culture of the future engineer from a methodological point of view to understand the complex system that occurs as a result of integrative interaction of cultures, reflecting different aspects of mathematical nature: epistemological, linguistic and cultural self education. Herewith epistemological culture involves the formation of mathematical knowledge and, based on them, the development of relevant skills. Language culture involves the mastery of mathematical symbolic language and speech. Self education culture shows the degree of development of mathematical knowledge and skills through self-study mathematical literature for practical application in future of professional activities. These structural components are inextricably linked and form a single entity – mathematical culture of a student [8].

Abovementioned function is based on the fact that by using mathematical language is performed transmission of mathematical heritage, mathematical culture in general, it becomes possible to exchange professional achievements and, equally important, emerging issues, thoughts, intentions. This universality of the language allows professionals to communicate in any branch and understand each other without limits. Unique character of universal clarity of mathematical language can be comparable only to the language of music, art or dance. In this comparison is clearly seen culturological background. Universal sign system of mathematical language is used completely in all sciences, thus integrating them into a single planetary scientific knowledge [4].

As you know, transmission of mathematical culture is carried out through the inheritance of individual experience accumulated by mankind, but not carried out automatically, causing the need of a systematic process in some way of directed formation

and development of culture named above, based on scientific research. Under professionally oriented formation of mathematical culture of the future professional field of software engineering we will understand the purposeful, gradual, systematic process of appropriation by a personality mathematical experience of mankind required for successful professional activity and its reflection, creativity and self-realization [5, p. 85].

Conclusions of the research. In conclusion let's note that mathematical language objectives mathematical culture of a future engineer. Carried out functional analysis of mathematical language and speech leads to the conclusion that the targeted implementation of functions of mathematical language in educational space of a technical university allows in-depth acquirement of mathematical language, promotes development of mathematical speech of subjects of education. Prospect of further scientific studies we consider identifying psychological and educational conditions in the training of future engineers for in-depth study of mathematical language and the ability to use it in practice, and also creating appropriate methodological support for the development of mathematical speech in students.

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Стаття надійшла до редколегії: 11.10.2016