PLACE OF LATIN IN CONTEXT OF TRENDS IN MODERN INTERDISCIPLINARY STEM EDUCATION

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Summary

The article attempts to rethink the meaning of modern education in the context of combining two opposing trends, to determine the status of Latin in the context of trends regarding modern education, which covers different fields of knowledge and combines interdisciplinary approaches. The solution to this issue is seen in the creation of a highly professional philosophy of education, where one of the leading places will be occupied by a combination of humanities, natural sciences and exact sciences. A special role in this process is taken by to Latin as a fundamental discipline in the process of language training of future specialists in the field of modern technologies. The prestige of Latin as a subject is that Latin for many centuries has played a significant role in the education system, in particular in specialized one, because this language is provided with vocabulary to explain certain abstractions. The article concludes that it is necessary to motivate future specialists to study Latin, which not only forms the fundamentals of the terminological base, but is a means of raising the level of scientific culture of future mathematicians, physicists, and IT specialists. Studying Latin at the departments of exact disciplines will help students not only to have a deeper understanding of terminology in their native language, but also to master the language competence required in research work.

Keywords: The Latin language, exact disciplines, terminological base, mathematical sciences.

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1. Introduction

Acquisition of modern professions requires comprehensive training and knowledge in various educational fields of natural sciences, engineering, technology, programming, etc. The development of innovative technologies and new areas of science needs a creative approach not only in solving issues of research, but also in the implementation of practical tasks. Therefore, in the process of training highly qualified personnel, along with the formation of purely professional skills, it is necessary to develop the creative potential of the individual. Without studying the humanities, which should take place along with the study of professional disciplines, training of modern level specialists turns into a challenge. The topicality of this paper is determined by the need to rethink the meaning of modern education in the context of combining two opposing trends: training of personal, individual Mind and Intellect, and development of sophisticated techniques and skills to extract other people's information and use other people's Intellect / mind. The solution of this issue is seen in the creation of highly professional philosophy of education, where one of the leading places will be occupied by the combination of humanities and natural sciences. A special role in this process is taken by Latin as a basic discipline in the process of language training of future specialists in the field of modern technologies.

The purpose of this research is to identify the place of Latin in the context of developing trends in STEM education and to prove the effectiveness of the study of the ancient language in the structure of a multidisciplinary approach to training in the exact sciences.

2. Research analysis

STEM is a term used to combine disciplines that cover the natural and exact sciences, as well as engineering and programming. STEM (S – science, T – technology, E – engineering, M – mathematics). *(Hlosarii terminiv STEM-osvity, 2021)*.

Theoretical aspects of the issue of STEM education are considered in the works of many modern researchers. In particular, in the works of Wolins, Inez S. "Interdisciplinary Teaching: Branches, Ties, and New Connections *(Wolins, Inez S., 1992)*", Elizabeth A. Berman, Jodee L. Kuden "Interdisciplinary Approach" *(Berman, Kuden, 2017)*, Holland Lorna "How to teach children woodworking through S.T.E.A.M fields" *(Holland, 2017)*, Radul S. "Professional Self-Actualization of a Specialist in Context of Computer Tendencies of Current STEM Education: Foreign Experience" *(Radul, 2018)*, Romanko I. "Technology "Science-Practice-Culture" in STEAM Education" (*Roman'ko, 2018*), Zaskalieta S. "Application of Interdisciplinary Relations Principles in Higher Education: Foreign Experience" *(Zaskalyeta, 2020)*. Deron Cameron, Former UPES Principal – US's 1st STEAM Certified School, Current TCSS Curriculum Coordinator notes that "STEAM represents a paradigm shift from traditional education philosophy, based on standardized test scores, to a modern ideal which focuses on valuing the learning process as much as the results *(Holland, 2017)*.

The introduction of a new educational paradigm involves the intertwining of different, from the point of view of the traditional paradigm, educational disciplines. Technology and technical creativity in modern society are actively used in the humanities, while the achievements of the humanities are implemented in innovative technologies and fields of science that are related to the exact and natural sciences. For example, people in creative professions (musicians, writers, designers, etc.) are taught not only the art, but also the skills of writing computer programs. In turn, artificial intelligence systems are developed on the basis of the creation of symbolic systems that mimic high-level mental processes: reasoning, thinking, emotions, language, creativity, etc., which are part of humanitarian disciplines. Thus, it can be argued that nowadays the process of globalization has covered not only the economic, market and social spheres, but also affected education. Globalization not just changes the system of subjects studied, it requires the improvement of teaching the exact sciences, including physics and mathematics with focusing on the current day specifics. Physics, mathematics, cybernetics, while being studied, should be perceived not just as scientific facts and formulas, but as a mechanism for purposeful formation of scientific thought in students undergoing the process of cognition the world around (*Kuz'menko, Dembits'ka, 2017*). Knowledge, education, information are becoming new raw materials in international commerce, sources of power, important components of individual and corporate wealth. New technologies and the formation of labor in such societies are going to play a dominant role. Education is a workforce whose consciousness is already prepared for innovations and practical work with these new technologies *(Pedagogika i psikhologiya inklyuzivnogo obrazovaniya: uchebnoye posobiye, 2013)*. Under such conditions, in the structure of training high-level specialists, especially in the format of higher education, there is a need to rethink the essence of the humanitarian approach to education, which is based on European civilization as a unique world civilization, and rethink the educational processes that formed the basis of the latest man-made society. Therefore, the creation of modern tools

and the development of skills for their application is inextricably linked with the use and interpretation of the basic principles based on culture worldview. The study of Latin will not only form fundamentals of the terminological base, but also will be a means of raising the level of scientific culture of future mathematicians, physicists, and IT specialists.

3. Latin in the context of mathematical sciences

Latin has always been important for exact disciplines. M. Copernicus (1473–1543), F. Kepler (1571–1630), P. Fermat (1601–1665), I. Newton (1642–1727), and L. Euler (1707–1783), K.F. Gauss (1777–1855) wrote their scientific works in Latin, while G. Galileo (1564–1642), R. Descartes (1596–1650), B. Pascal (1623–1662) used it partly. The treatise "On Proportions" (De proportionibus) by the mathematician and mechanic Albert of Saxony, "Summa de arithmetica, geometria, proportioni et proportionalita", "Algebra" by Christopher Clavius, "Mathematicae collections" by Papius of Alexandria, etc. were published in Latin. Friedrich Nietzsche noted that Latin cannot be perceived passively, understood inattentively – it is a language with excellent conciseness – "this is the minimum of the sum and number of signs and this is the maximum achieved by the energy of signs" *(De Larminat, 2016)*. Therefore, it is natural that the Latin language for centuries remains the main source of scientific terminology. "Science is international in nature, and for it the presence of a single language alongside the national languages, which serves the purposes of international communication, is a positive factor. The Latin language retained its significance even when the national languages of Europe, borrowing Latin and Latinized Greek vocabulary, became an effective tool of scientific creativity" *(Borovskiy, 1991)*.

Each language is multifunctional, it classifies, systematizes, conceptualizes the world around it in its own way, in accordance with the accumulated practical experience, consistent with the traditions and principles created during centuries of its existence. Latin is one of those languages that are still active in the field of writing and publishing books. Latin is studied in many educational institutions and at the same time not always solely at philological direction. The reason is that the Latins after leaving the live communication retains the ability to develop. Its high cultural significance has a significant / great influence on the living languages in which it operates. However, we can mention the many artificial languages that were created to facilitate communication between speakers of different languages, sometimes distant from each other, to become the basis for the formation of international scientific nomenclature. The most successful attempt was the creation of Esperanto, though it was not so successful as to displace Latin. We should also keep in mind that Esperanto, like most artificial languages, is still based on Latin. The prestige of Latin as a subject is that Latin for many centuries has played a significant role in the education system, in particular in specialized one, because this language is provided with vocabulary to explain certain abstractions.

The well-known modern mathematician Laurent Schwartz, who made a notable contribution to the development of functional analysis and a Fields Prize winner, noted that the study of mathematics and the study of Latin have many features in common (*Schwartz, 1997; 42-43*). Both in the study of Latin and in the study of mathematics, as Laurent Schwartz points out, consistency and imitation are very important. Mathematics and Latin are combined due to specificity of cases in the application of complex rules: whether grammatical rules used in translation, or in the application of theorems in mathematical exercises, "… the same desire to leave nothing behind is not only practical, it brings great pleasure from dominance over the subject" (*Schwartz, 1997;42-43*). Knowing Latin and ancient Greek well, he could not fail in mathematics, as his contemporaries point out.

The great geometer Lagrange advised Augustine-Louis Cauchy, a famous French mathematician, to master classical languages before taking mathematics seriously. Latin and Greek not only did not detract from Cauchy's brilliant mathematical career, but undoubtedly served it. Henri Poincaré, another great mathematician, noted that scholars who have had the opportunity to study Latin have always noted its high cost, thanks to the harmony and logic of language structure (*(De Larminat, 2016)*. Therefore, today the question of the need to study classical languages along with mastering the exact disciplines is the subject of active discussion in the European media.

According to research conducted by R.V. Milenkova, the teaching of Latin in US schools is based on methodological standards that have been developed taking into account modern requirements for the quality of higher education, and allow basic knowledge of Latin to focus on professional terminology. (*Paradigmy kul'turnoy pamyati i konstanty natsional'noy identichnosti* , *2020)*. Unfortunately, our students who master technical specialties do not have a basic knowledge of Latin, which to some extent complicates the understanding of the basics of special terminology. However, back in 2001, Lviv University introduced the teaching of Latin in all specialties, which prompted specialists to create specialized textbooks, which have not been available in Ukraine or abroad. The first such textbook was "Latin" by N. Revak and V. Sulyma. In 2015, a textbook of Latin for mathematics and physics students was created. The authors of the textbook note: "The study of Latin for a mathematician or physicist should be a way to a deeper and broader understanding of his own profession, to understanding of culture in general" *(Nazarenko, 2012:305).*

4. Latin as the basis for creating modern terminology

Studying Latin at the departments of exact disciplines will help students to have a deeper understanding of terminology in their native language and in mastering the language competence required in research work. Knowledge of Latin will contribute to the successful acquisition of foreign languages, as a number of Latin abbreviations do not require translation from any European languages: 1) sq; sqq = sequens; sequentia;2) sc.; scil. = scilĭcet; 3) viz.1 = videlĭcet; 4) v; q.v. = vide; quod vide; 5) v.s. = vide supra; 6) v.i., v.inf. = vide infra; 7) v.v. = vice versa. Special expressions that also do not require any additional translations or additional explanations: Terminus ad quem;. Terminus a quo; Terminus ante quem; Terminus post quem; Technical terms, etc.

One can also note the words of Latin origin, accordant with the words of the Ukrainian language, so their English equivalents are remembered faster. For example, canon, substance, hypothesis, bonus, theory, manipulation, formula, excursion, veto, campus, energy. The associative perception of such terms affects the facilitated assimilation of such words by students, therefore, forms not only logical thinking, but also linguistic (speech) conjecture. In addition, the study of Latin also develops a prediction mechanism, which is an integral aspect of the student's linguistic activity. Some English terms of Latin origin, for example, dis-cretio, ōnis f discreteness; ex-pōno, ĕre, – eksponenta – exponential curve, exponential; extremism, a, um-extremum; factor, ōris m- factorial; figure, ae f- figure; formula, ae f- formula; functio, fnis f- function; inter-polatio, ōnis- interpolation; degree, us m- degree; inter-vallum, and n-interval interval; linea, ae f; locus, and m; modŭlus, i.; maxĭmus, a, um; minus., numeration help to build associations that lead to their recognition in the native language.

A number of mathematical terms of Latin origin such as discriminant (<discriminans: active adjective from discrimĭno, āre, āvi, ātum – to divide, distinguish); coefficient (<co

(indicates the commonality of action) + efficiens active adjective from efficio, ĕre, fēci, fectum – to produce, condition), "longitūdo coëfficiens" – "auxiliary length" factor in the term of the equation, which added to it the required number of measurements for homogeneity), etc., should also be noted, as they will remain relevant in scientific discourse due to their ability to outline in "one word a concept that requires several words". Understanding the semantics of Latin origin terminology will form the basis of the future professionals' scientific worldview, and give better understanding of the processes in the field of new technologies that actively use new information and communication services, systems and environments, as well as semantic networks, the correctness and effectiveness of which depends on the amount of training (a large amount of data and its quality). For example, the term ordinate comes from the Latin expression *ordināte* ductae, "orderly" drawn lines. Here is an explanation of this term given in a Latin textbook for mathematicians: "If the points on a parabola or other curve are connected by parallel chords so that the diameter of the parabola, crossing these chords, divides them in half, then half segments of parallel chords will be exactly what Apollonius called "orderly drawn" lines. Therefore, from each point A of the parabola one of the orderly lowered segments AB can be lowered to the diameter... In Latin, this expression was transmitted as "ex diametro *abscissa* ad verticem". Hence the term abscissa. If a parabola (or other conical section) is inscribed in a Cartesian coordinate system so that its diameter (axis) is the x-axis, the vertex is the origin, and the tangent to the vertex is the y-axis, then the coordinates of the curve points will be given by Apollonius "orderly" and "drawn" lines, i.e. – ordinates and abscissas. To apply the coordinate method in stereometry, we had to add another axis. It was called "added" (applicāta). The spatial Cartesian coordinate system was introduced by the French mathematician F. Lagire (1679). He was the first to use the term "beginning" of coordinates. In Latin origin is origo. Hence the tradition of marking the origin of coordinates with the letter O (or from the French origine). The notation *x, y, z* for the coordinates was adopted at the beginning of XVIII century, due to the fact that in general the tradition of denoting unknown quantities by the last letters of the Latin alphabet (*x, y, z*), and known ones with the first (*a, b, c*) was started by R. Descartes". Such knowledge not only lays the foundations of the terminological basis, but also forms scientific literacy in future professionals (*Dombrovs'kyy*, *2015:154).*

Mathematical terminology of Latin origin can be expressed not only by words, but also by signs, namely the sign of the paragraph § (abbreviation of the Latin expression signum sectionis (§<ss) – "section sign". *(What does the symbol mean; 2021)*

Paragraph sign ¶. It is assumed that the sign ¶ comes from the Latin letter C, as the Latin word capitulum means "chapter". The paragraph sign is used in computer typesetting programs and text editors to indicate the presence of an unprinted special translation code at the end of the paragraph. (*Dombrovs'kyy*, *2015:155)*)

Non-verbal terms are interpreted by means of verbal language" plus (+), minus (-), multiplication sign (x or ·) etc., or graphs and formulas containing letters of the Latin alphabet S = ab. Since *verbum est signum*, according to Aurelius Augustine in mathematical language symbols are used: α, β, γ ..., or A, B, C ..., or Δ, δ, E, ε, Z, η, which express concepts that are not related to real things and can be used "to indicate the headings of different classification systems" (*Zaryts'kyy*, *2004;72)*.

An important section in the study of Latin terminology is the analysis of borrowed Latin roots. Such an analysis is meaningful and constructive for understanding and perceiving not only purely English vocabulary to which it tends. One Latin root can form up to twenty or more derivatives in English or in other Romance languages expressed by different parts of speech (verbs, adverbs, nouns and adjectives). For example, the Latin root dict was used to obtain

such derivative forms as contradict, dictate, dictation, dictator, dictatorship, dictatorater, dictatori-ally, dictatorial, edict, predict, dictionary, dictaphone, dictabelt. The root fōrm- / fōrma- (form in English) is word-forming for almost forty derivatives: conformance, conformant, conformity, counterreformation, deform, deformable, deformation, deformity, disinformation, formable, formal, informal, formally, informally, formality, formant, format, formation, formative, formula, formulary, formulation, inform, informal, informality, informant, information, informative, irreformable, malformation, nonconformance, per-formance, preform, preformat, reformable, reformat, reformation, reformatory, transform, transformable, transformation, transformational, transformative, triform, triformity, uniform, uniformity. Move, mot (movere, motus / move, mo-tion) formed such words as mobile, immobile, mobility, motor, momentum, move, mover, to move, movable, immovable, motionless, movement.

Word-forming elements can be not only Latin roots, but also Latin prefixes, such as sub- (submarine, subconscious, subsoil, subway, subhuman, substandard, subjacent); inter- (international, interfaith, intertwine, intercellular, interject, intergovernmental, intergenic, interface); de- (deactivate, debone, defrost, decompress, deodorize, deplane, dehydrate); pre- (preconceive, preexist, premeditate, predispose, prepossess, prepay, prelaunch, predate). Analysis of Latin stems, which form a series of English words, allows students to "decode" the meaning of many words. Such decoding can be both an interesting game and an opportunity for a deeper understanding of professional text material.

Here is an excerpt from the professional literature text:

Newton was the first person to figure out the tangent-line definition of velocity for cases where the x−t graph is nonlinear. Before Newton, nobody had conceptualized the description of motion in terms of x−t and v−t graphs. In addition to the graphical techniques discussed in this chapter, Newton also invented a set of symbolic techniques called calculus. If you have an equation for x in terms of t, calculus allows you, for instance, to find an equation for v in terms of t. In calculus terms, we say that the function v(t) is the derivative of the function x(t). In other words, the derivative of a function is a new function that tells how rapidly the original function was changing.

5. Conclusions and suggestions

Determining the place of the Latin language in the process of implementing the principle of integrative education of highly qualified specialists, the formation of their scientific literacy and professional terminological competence is timely. As the analysis shows the percentage of words of Latin origin in the professional literature is extremely high. Latin as a language that is able to actively develop a figurative system of thinking and logic, should take a worthy place in the structure of STEM education, which is actively implemented in many countries around the world. Understanding the semantics of Latin origin terminology will form the basis of the future professionals' scientific worldview, thus they will better understand the processes in the field of new technologies that actively use new information and communication services, systems and environments, as well as semantic networks, the correctness and effectiveness of which depends on the amount of training, large amount of data and its quality.

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