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THE ROLE OF MATHEMATICS IN AESTHETIC EDUCATION OF STUDENTS IN TECHNICAL UNIVERSITY
О РОЛИ МАТЕМАТИКИ В ЭСТЕТИЧЕСКОМ ВОСПИТАНИИ СТУДЕНТОВ В ТЕХНИЧЕСКОМ ВУЗЕ

Summary. *In this article there is being explored of mathematics in aesthetic education of student in technical university. Aesthetic education of future specialist and fundamental component of professional education are tightly connected with each other. Aesthetic component of students' fundamental preparation is an inherent part of educational process in technical university and weighty impacts on formation of future specialist's individuality.*

Key words: *aesthetic education, mathematics, technical university.*

Аннотация. *В статье исследуется роль математики в эстетическом развитии студентов в техническом вузе. Эстетическое воспитание будущего специалиста и фундаментальная составляющая профессионального образования тесно связаны между собой. Эстетическая составляющая фундаментальной подготовки студентов является неотъемлемой частью воспитательного процесса в техническом вузе и осуществляет весомое влияние на становление личности будущего специалиста.*

Ключевые слова: *эстетическое воспитание, математика, технический вуз.*

Mathematical preparation is a basis for wide culture-oriented preparation of future specialist in technical university. Mathematical models allow to recreate a big amount of manufacturing processes, to calculate their characteristics and make predictions considering their development. That is why the mathematical apparatus is a powerful tool for solving scientific and technical problems, but it is illegal to obscure the aesthetic importance of natural sciences.

History of mathematics is auspicious material for students' aesthetic taste development, ever since they were at elementary school. Mathematics, with the richest and the most exciting history, perfection of language, high level of logic and other aspects, has a great potential of aesthetic influence on students. Famous mathematicians of all times, from Euclid and Pythagoras to A. Kolgomarov and N. Wiener, indicated aesthetic possibilities of the subject. For centuries ways of math and different kinds of art often intertwine (painting and mathematics, music and mathematics, architecture and mathematics). Historical information about famous people - is the great material for human's aesthetic education.

English mathematician J. Young emphasized that beauty of mathematics (it's simplicity, symmetry, brevity and completeness) is allowed to and ought to be felt by even very small children. When this subject is expressed in a proper way and correctly, then learning is accompanied by emotions and enjoying the beauty. J. von Neumann emphasized that math, as well as art, is driven by almost only aesthetic motive. J. Hadamard claimed that when scientist sees structurally imperfect, asymmetrical, «lopsided» mathematical construction, he starts to feel the need of considerable activity in harmonic supplementation of it. A. Pushkin said that inspiration in geometry has to be not smaller than in poetry. Academic A. Gonchar once said: «Mathematics is the element of human shared culture. Pythagorean Theorem does not concede beauty, significance and greatness of any cultural heritage of our civilization».

Since ancient times scientists emphasize the aesthetic value of natural sciences, it's impact on human ability to perceive harmony and desire to

perfection. In Aristotle's opinion, mathematics detects order, symmetry and certainty, which appear to be the most valuable kinds of beauty. Galilei claimed that it is impossible to comprehend the language of nature if you do not the language of math, and Kant highlighted that in every natural science there is concluded as much truth as mathematics. Importance of exact sciences for aesthetical education of individuality was recognized by scientists centuries ago. H. Poincare wrote: «Mathematics follows a three-fold objective. Is has to provide tools for nature exploration. Apart from that, it follows philosophical objective, and I dare to claim, aesthetical one».

Some authoritative scientists relate appearance of «golden ration» term to Leonardo da Vinci. Two quantities are in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities. It is considered that this proportion is the manifestation of harmony and world order, perfect Universe model. Golden ratio is used in painting, sculpture and in temple construction. Proportions of the Great Pyramids - the 1st Wonder of the World, also obey golden ratio.

Geometry often is called the grammar of architect. All masterpieces of architecture are created under laws of geometry. For example, Pyramid of Kheops is called the «direct treatise of geometry». The major beauty of the architecture is in it's symmetry.

In work «Union of math and aesthetics» [1, p. 120] A. Voloshinov emphasized that similarity between aesthetical perception of reality in math and art was noticed by Pythagoras, who found the law of consonances. In accordance with the antique tradition, Pythagoras discovered that two strings produce favorable harmonic sound (consonance) only in case when their length are in proportion as numbers of first quarter 1:2 (octave), 2:3 (quint) and 3:4 (quart). Law of consonances first ever provided a math form for physical phenomenon – sound of string, and pointed on existence of other numerical patterns in nature.

J. Kepler considered that math is the prototype of world's beauty. N. Wiener wrote: «I don't think there is someone of non-mathematicians is able to get used to the thought that digits may represent cultural or aesthetical value by themselves or have any relations to such things as beauty, power, inspiration. I strongly protest against this distorted image of math». In work «Mathematical education in area of aesthetical experience» L. Lurie quotes F. Hutcheson, Scottish philosopher of XVIII century, who highlighted the following features of aesthetical beauty and sublimity in his work «A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful in two treatises»: unity in diversity, the ideal of scientific truth's universality, searching for truth that is not obvious and needs a proof [2, p. 33].

Scientists provided different formulae for mathematical object's aesthetic attractiveness during the process of math beauty exploration. So, mathematician and teacher V. Boltyanskiy offered the formula of grading the beauty of math object: beauty = visibility + suddenness = isomorphism (equivalence) + simplicity + suddenness [3, p. 41].

G. Birkhoff found the following formula of aesthetical value of scientific object: value of beauty = value of order / value of efforts in need to understand the essence of object [4, p. 70].

Scientists divide the aesthetics of exact sciences into external and internal. External aesthetics of exact sciences is based on aesthetics of math knowledge that is a necessary tool for understanding laws of harmony and beauty of surrounding world. N. Firstova highlights the aesthetics of geometrical forms and analytical records [5, p. 98] in external aesthetics of exact sciences. External aesthetics of geometrical forms concludes in beauty of geometrical drawings, ornaments, polyhedrons, symmetry, proportions (including the term of golden ration). External aesthetics of analytical records concludes in preciseness, universality and logic records of scientific facts, in beauty of mathematical,

physical and chemical formulae, in utilizing of table or matrix methods of representation of educational material.

Internal aesthetics of exact sciences is connected with intelligent beaty of scientific knowledge. It is based on scientific objects' features (facts, theorems, tasks, evidences), being thankful to which these objects can evoke the essence of grace [6, p. 8].

A. Khinchin in his work «About the upbringing effect of math classes» [7, p. 130] highlights the following: «In accordance with many years of my own experience, learning the math science inevitably, tacitly and step-by-step brings up a row of traits in young person and that traits have moral coloring and can become the most important in person's ethos in future». While talking about upbringing moment of math lessons, A. Khinchin lists features of math science which give it one or another advantage over other disciplines considering bringing up [7, p. 131, 133, 141, 147, 151, 153]:

1) Teaching to *completeness of argumentation.* In math there is no and can never be «half-proved» or «almost proved» statements.

2) Fight with *non-arguable analogies.* In various life situations math-trained mind helps human to get to conclusion that it is restricted to consider received result to be strictly determined without sorely check.

3) Domination of *logic scheme of thinking.* Mathematician, who loses this scheme of thinking at least for a while, loses an ability to think in a scientific way at all.

4) *Laconism*, conscious pursuit of finding the shortest logical chain that leads to the claimed goal, not interrupting for side representations and not losing direct contact with the major line of reasoning.

5) *Meticulous accuracy of symbolics.* Each math symbol has strictly determined meaning, and replacing it with another symbol or transposition to another place usually results in distortion, sometimes even complete destruction of meaning of the exact statement.

6) *Correct, objective, non-tendentious argumentation.* Success can only lead to independent and dispassionate thinking.

7) *Tenacity and courage* bring up four respective human characteristics: diligence, conscientiousness, perseverance in following the chosen goal, ability to never stop in case of difficulties and not to be discouraged by failures.

8) *Creative researching character of math problems.* Who, once felt noble happiness after creative achievement, will never regret to make an effort to feel it one more time.

Important component of internal aesthetics of exact sciences is aesthetics of the scientific education process, and exactly are feelings that students get from becoming step-by-step acknowledged in science and creating the end product in result of scientific activities. Scientific preparation enhances the development of individuality, intelligence and forms the need in professional growth and self-development [8, p. 92].

Aesthetical education of future specialist and fundamental component of professional education are closely linked. Scientific preparation has a great impact on individuality of technical university student. And not only intelligent traits are meant here (such as flexibility of mind, criticism, logic, consistency), but also professional traits (tenacity, independence, integrity, responsibility) and cultural properties (ability to see the grace, ability to analyze results of own activity from the point of view of technical and aesthetic value).

Conclusions. Aesthetics of geometrical constructions and accuracy of logical proofs ability to see the inner beauty of mathematical solutions form students' aesthetic attitude to the work process itself and to results their activity. Math preparation provides to the student the exact math apparatus that will not only allow him to learn special disciplines and to master the profession, but also to self-develop and to increase own professionalism level, and aesthetic component of fundamental preparation of students is an integral part of

educational process in technical university and significantly impacts on future specialist's individuality formation.

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