



ASSESSMENT OF STUDENTS' KNOWLEDGE IN CLASSES USING THE METHOD OF CONFUSED LOGICAL CHAINS

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Abstract: The article proposes to use the entangled logic chain method to increase student activity during lectures on theoretical mechanics. The possibility of using the method for a separate topic and section of theoretical mechanics is shown, and the method is also used for conducting intermediate and final controls.

Key words: theoretical mechanics, statics, force, system of converging forces, equilibrium, geometric condition, analytical condition, fundamental theorem of statics, moment of force, pair of forces.

Currently, the main problem in the field of higher education is the problem of improving the educational process, which reveals the content of education, teaching methods, means, forms, as well as the interaction of teachers and the educational activities of students. At the same time, special attention is paid to modern methods of teaching disciplines, such as information and pedagogical technologies, which dramatically increases the efficiency of student learning.

Theoretical mechanics is the main technical subject for the training of civil engineers. In addition, it is basic for strength of materials, structural mechanics, hydraulics and many special disciplines. Therefore, special attention is paid to the teaching of theoretical mechanics based on advanced pedagogical technologies. The teaching staff of higher educational institutions have conducted numerous methodological studies on teaching students using modern teaching methods. The organization of lectures using Venn diagrams in the classroom is given in [3,6,8,11,16,19,20,28,40]. Research [1,10,25,27,39] provides practical solutions to increase the visibility of lessons through the application of the cluster method to the educational process. Studies [4,5,9,13,14,18,30,31,32,33,34,37,41,42] discuss various ways to increase student activity in the classroom. An unconventional method based on the production of electricity using wind energy is described in [2,43,44]. Applications of the method of entangled logical chains are given in [7,12,15,17,21,22,23,24,26,29,36,39].

Let's consider a method that has recently been widely used in teaching the method of entangled logical chains. This method is used to study the cause-and-effect relationships of an event. Using this method, students learn to coordinate the concepts of the topic being studied, such as formulas, expressions, definitions, theorems, when information on several topics being studied is mixed together. Students are presented with a set of facts to be studied in a confusing (distorted) chronological order of cause and effect. Students must arrange them in true and correct order, and students can also compose a text using additional words to represent the facts.

Let us consider the application of this method in the educational process on the topic "System of Converging Forces" related to the statics section of theoretical mechanics. Information about the system of forces, addition and equilibrium is provided to students using a convoluted logic chain method. The teacher distributes copies of the table to students according to the number of students in the group. Students study this table carefully and write the answer number for each

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question on the left into the number on the right. The teacher collects the answers of all students, checks them and announces the results.

Determines compliance :

| | | | |
|---|---|---|---|
| 1 | Formula for determining an equally acting system of converging forces | 1 | $\sum F_{kx} = 0, \sum F_{ky} = 0, \sum F_{kz} = 0$ |
| 2 | What system of forces is called descending | 2 | We transfer the first force parallel to itself, then we transfer the second force from its end, and so on. The resultant is the vector that closes the force polygon - connecting the beginning of the first force with the end of the last |
| 3 | Analytical condition for the equilibrium of a system of converging forces | 3 | $\vec{R} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \dots + \vec{F}_n = \sum \vec{F}_k = 0$ |
| 4 | Methods for adding a system of converging forces | 4 | If a rigid body is in equilibrium under the action of three non-parallel forces lying in the same plane, then the line of action of these forces intersects at one point |
| 5 | Three Forces Theorem | 5 | Parallelogram, triangle and polygon forces |
| 6 | Geometric equilibrium condition for a system of converging forces | 6 | $\vec{R} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \dots + \vec{F}_n = \sum \vec{F}_k$ |
| 7 | How to construct a force polygon | 7 | If the lines of all forces intersect at one point |

Right answers (6 , 7,1,5 , 4 , 3 , 2).

In the future, we will use the method to assess students' knowledge in the statics section. In this case, the number of questions asked to students will be increased in accordance with the increase in the proposed educational material. The questions are taken from the department's data bank, created in advance by the teaching staff. When conducting tests at the end of a section, as well as intermediate tests, the method can be effectively used to assess students' knowledge.

Below is an example of a variant of determining students' knowledge based on the results of the statics section.

Determines compliance :

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| | | | |
|--------|--|--------|---|
| 1 | Define a material point | 1 | The number of unknowns in the problem is equal to or less than the number of equilibrium equations |
| 2 | What is power | 2 | Along the thread to the suspension point |
| 3 | The moment of force relative to a point is - | 3 | Symmetry, partitioning, complementation, integration, weighting |
| 4 | Analytical equilibrium conditions for an arbitrary plane system of forces | 4 | $\vec{M}_k = \sum \vec{m}_k = 0$ |
| 5 | Statically definable problem | 5 | A rigid body whose dimensions can be neglected when considering motion |
| 6 | Methods for determining the center of gravity of a solid body | 6 | The product of the modulus of force and the shoulder taken with the corresponding sign |
| 7 | How the thread reaction is directed | 7 | A measure of the mechanical interaction of two bodies |
| 8 | Fundamental theorem of statics | 8 | Geometrically unchangeable structure created from rods under the influence of applied forces |
| 9 | What is a farm | 9 | An arbitrary spatial system of forces, when brought to the center, is replaced by a principal vector equal to the geometric sum of the given forces and a principal moment equal to the geometric sum of the attached pairs of forces |
| 10 | Geometric equilibrium conditions for systems of force pairs | 10 | $\sum F_{kx} = 0, \sum F_{ky} = 0, \sum m_A(\vec{F}_k) = 0$ |
| eleven | Analytical conditions for the equilibrium of an arbitrary spatial system of forces | eleven | $\sum F_{kx} = 0, \sum F_{ky} = 0$ |

| | | | |
|----|--|----|---|
| 12 | Equilibrium conditions for a plane system of converging forces | 12 | $\sum F_{kx} = 0, \quad \sum F_{ky} = 0,$ $\sum F_{kz} = 0,$ $\sum m_x(\vec{F}_k) = 0, \quad \sum m_y(\vec{F}_k) = 0,$ $\sum m_z(\vec{F}_k) = 0.$ |
|----|--|----|---|

Right answers (5 , 7 , 6,1 0 , 1,3 , 2 , 9 , 8,4,12,11) . _

To determine the level of knowledge students acquired while studying theoretical mechanics, the entangled logic chain method can be used. In this case, the number of questions offered to students increases and ranges from 15 to 20 questions. Below is a version of the final work on theoretical mechanics carried out for civil engineering students.

Determines compliance :

| | | | |
|---|---|---|---|
| 1 | Analytical equilibrium conditions for an arbitrary plane system of forces... | 1 | $m\ddot{x} = \sum F_{kx}, m\ddot{y} = \sum F_{ky}, m\ddot{z} = \sum F_{kz}$ |
| 2 | Show where the natural coordinate axes are correctly indicated | 2 | $\vec{a}_{ab} = \vec{a}_r + \vec{a}_e + \vec{a}_{kor}$ |
| 3 | The vectors of velocity and tangential acceleration are always directed... | 3 | The point at which at a given moment in time the speed is zero |
| 4 | What formula is used to determine the sliding friction force... | 4 | $\vec{a}_B = \vec{a}_A + \vec{a}_{AB}$ |
| 5 | The moments of inertia of a rigid body relative to the coordinate axes are equal to ... | 5 | $m\vec{v}_1 - m\vec{v}_0 = \vec{S}$ |
| 6 | What is the instantaneous velocity center | 6 | tangent to the trajectory |

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| 7 | The platform moves at a speed of 4 m / s in a horizontal section of the track. If you find The cart in it moves in the opposite direction with a speed of 2 m / s , then the absolute speed of the cart is equal to what | 7 | 48 m/s |
| 8 | The wheel performs rotational motion according to the law $\varphi = 6t$. Find the linear speed of a point located at a distance of $R=0.5$ m from the axis of rotation. | 8 | $\vec{a}_{kor} = 2\vec{\omega}_e \times \vec{v}_r$ |
| 9 | The law of motion of damped oscillations of a material point has the form... | 9 | $\ddot{x} + k^2x = 0$ |
| 10 | Give an example of complex point motion | 10 | At the point of intersection of perpendiculars to two point velocity vectors |
| eleven | State the theorem on the projections of the velocities of two points of a body in plane motion. | eleven | $A(\vec{G}) = \pm mgh$ |
| 12 | The differential equation of free oscillations of a material point has the form... | 12 | $x = \ell^{-bt} \sin(kt + \alpha)$ |
| 13 | Show the formula for determining absolute acceleration during complex motion of a point. | 13 | $M\tau nb$ |
| 14 | What is the acceleration of point B during plane-parallel motion? | 14 | $F_{Tp} = f \cdot N$ |
| 15 | The material point moves in a straight line according to the law $x=12t^2$ m . Find the speed of the point at time $t =2$ s | 15 | 2 m/s |
| 16 | Where is the instantaneous center of velocities? | 16 | Movement of a conductor with a moving train |

| | | | |
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| 17 | The theorem on the change in momentum of a material point.... | 17 | $I_x = \sum m_k (y_k^2 + z_k^2), I_y$ $= \sum m_k (x_k^2 + z_k^2), I_z$ $= \sum m_k (y_k^2 + x_k^2)$ |
| 18 | The work of gravity is determined by the formula1 | 18 | Projections of velocities of two points of a body performing plane motion are equal to each other |
| 19 | What is the Coriolis acceleration? | 19 | 3 m/s |
| 20 | The differential equations of motion of a material point have the form | 20 | $\sum F_{kx} = 0, \sum F_{ky} = 0, \sum m_A(\vec{F}_k) = 0$ |

Right answers (20,13,6, 1 4,17,3 , 1 5 , 19,12,16,18,9 , 2 , 4 , 7 , 10 , 5 , 11 , 8,1) .

The convoluted logic chain method develops in students skills such as understanding the topics being studied, breaking them down into components, comparing them with other parts of the topic, applying the information received to a new topic being studied, as well as solving problems on this topic. Regular use of this method in lecture classes allows students to systematically study the materials of the subject, systematize what they have learned, divide it into parts, and distinguish basic concepts and theorems from each other. As a result, the level of students' knowledge will increase significantly, and student activity in the classroom will also increase. The teacher will have the opportunity to objectively and quickly determine the level of knowledge of students and successfully conduct intermediate and final tests.

When using the convoluted logic chain method to assess student knowledge, you should pay attention to the following factors:

- constantly expand the bank of questions on the subject.
- a bank of questions is compiled for each topic, section and for the subject as a whole.
- a bank of relatively easily solved problems by topic is created.
- to determine the level of mastery of the subject by students, versions of the table are compiled, consisting of 5-10 questions, in an amount equal to the number of students in the group.
- during intermediate control, tables with 12-15 questions are compiled for students.
- during the final control, tables consisting of 17-25 questions are developed.
- examples of a bank of questions and a bank of tasks and the procedure for filling out the table are regularly covered on the department's website.

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- a bank of questions and a bank of tasks for the subject are updated every academic year.
- you need to keep in mind that if you increase the number of questions too much (more than 25), the result will be incorrect.

In conclusion, it is important to note that the use of the method of entangled logical chains when conducting classes in theoretical mechanics and the use of the method to test students' knowledge leads to a qualitative improvement in students' knowledge, which has been proven by numerous pedagogical experiences of members of the department in classes.

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