# L.N. Tolstoy's Didactics as a Vector in Modern Education

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**ABSTRACT**
The paper analyzes the work of L. N. Tolstoy as a teacher, the creator of an original democratic and humane educational system. It is emphasized that the ideas of L. N. Tolstoy can be adapted and successfully applied in modern conditions. This is the idea of non-violent teaching and education, which runs through the pedagogical work of the scientist. L. N. Tolstoy emphasized the need for an individual approach to each student, he paid great attention to practical classes and natural experiments, advocated for giving children freedom in choosing educational activities and topics. The work emphasizes the importance of the connection between different subjects in the didactic system of L. N. Tolstoy. Modern STEAM education (science, technology, engineering, art and mathematics) actively applies this principle, creating interdisciplinary curricula.

***Keywords:*** *pedagogy of non-violence; didactic system; physics; mathematics; observation; experiment.*

# ДИДАКТИКА Л.Н. ТОЛСТОГО КАК ВЕКТОР СОВРЕМЕННОГО ОБРАЗОВАНИЯ

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**АННОТАЦИЯ**
В работе анализируется творчество Л.Н.Толстого как педагога, создателя оригинальной демократичной и гуманной образовательной системы. Подчеркивается, что идеи Л.Н.Толстого могут быть адаптированы и успешно применены в современных условиях. Это идея ненасильственного обучения и воспитания, ккоторая красной нитью проходит через педагогическое творчество ученого. Л. Н.Толстой акцентировал внимание на необходимости индивидуального подхода к каждому ученику, он уделял большое внимание практическим занятиям и натурным экспериментам, выступал за предоставление детям свободы в выборе учебных занятий и тем. В работе подчеркивается важность связи между различными предметами в дидактической системе Л. Н. Толстого. Современное STEAM-образование (наука, технологии, инженерия, искусство и математика) активно применяет этот принцип, создавая междисциплинарные учебные программы.

***Ключевые слова****: педагогика ненасилия; дидактическая система; физика; математика; наблюдательность; эксперимент.*

A supporter of non-violent pedagogy, L. N. Tolstoy was convinced that education should be non-violent and free, because its quality determines what we now call upbringing. In the 1870s, L. N.

Tolstoy created the “ABC” and the “New ABC”, for which he even interrupted his work on “Anna Karenina” [1; 2]. These works form the basis of Tolstoy’s didactic system.

L. N. Tolstoy had long been nurturing the idea of an educational book for the very young. Its general plan, content and logical structure were developed for quite a long time. He often spoke about this activity with excitement: “What will come of this – I don’t know, but I put my whole soul into it.” Tolstoy associated his dreams with the “ABC”, believing that several generations of Russian children, from peasants to the tsar’s heirs, would study from it, receiving their first poetic impressions.

Count Tolstoy's "ABC" became an event in pedagogy. It largely justified the author's hopes. Meanwhile, many thought that elementary education was unworthy of the great writer's talent. The significance of the new pedagogical work was not immediately understood and appreciated by his contemporaries. However, Tolstoy was convinced that the spiritual development of a child begins with the first stage of education. Whether learning will be joyful for a child, whether he will develop a selfless interest in cognitive activity, whether he will subsequently put spiritual values above material goods - all this largely depends on his first steps into the world of knowledge. The development of the spiritual principle without school can hardly take place. This is its priority task, more important than simply communicating a certain amount of knowledge. This is what Tolstoy sought to solve not only with his "ABC", but also with "Russian Books for Reading". This is a kind of encyclopedia explaining the world around children. Enriching artistically, it reveals to children the basic concepts of physics, chemistry, mathematics, botany, zoology, talks about the life of plants, the external senses of humans and animals, the phenomena of magnetism, electricity and much more.

And just as Tolstoy's literary works marked a step forward in the development of world art, his pedagogical works were a unique contribution to the science of education and training. Teaching in Yasnaya Polyana was much more difficult than in a school with a strict schedule of lessons, compulsory discipline, a set of known means of reward and punishment. The teacher was required to have constant moral and intellectual tension, the ability to take into account the state and abilities of each of his students at a given moment, and pedagogical skill. Lev Nikolayevich's son S. L. Tolstoy recalls: “In the winter of 1872, my father made an experiment in the so-called Lancaster education. He entrusted me, my sister Tanya, and even my brother Ilya, despite the fact that he was not yet seven years old, with teaching the village children to read and write. Uncle Kostya Islavin also taught. The students came to our house: in the hallway and in the adjoining rooms, we each taught our own group of students. The experiment was quite successful, and my students and sister Tanya’s students mastered basic literacy; Ilya, however, was too young and, in addition, got into a fight with his students” [3, p. 32].

In didactics, L. N. Tolstoy was able to find himself at the level of the student and, together with him, comprehend a particular subject. For example, he recommended memorizing the multiplication table only up to five, and multiplying numbers from 6 to 10 was done as follows: subtract the number five from each factor, put the remainders on the fingers of both hands, bending them, and add the bent fingers together - these will be the tens of the product; multiply the remaining unbent fingers of both hands and add them to the tens. For example, you need to multiply 7 x 9. Subtract 5 from each factor, you get 2 and 4. Bend 2 fingers on one hand, 4 on the other. Their sum is 6. These are the tens. Multiply the remaining unbent fingers 1 x 3 = 3. Therefore, the product 7 x 9 = 60 + 3 = 63 [3, pp. 28 - 29].

The question arises: are the methods and techniques proposed by L. N. Tolstoy valuable for teaching mathematics in modern conditions? Are they not naive and primitive? After all, we live in a different century now, every schoolchild has a calculator or a computer. Should he be distracted by such unproductive methods of counting? And if we look at the problem more generally, the question arises about the advisability of studying grammar, classical literary works, and works of musical art in school. Modern technology allows us to make an instant search in any area of human existence, so is it worth bothering our children with many years of exercises? Anticipating such a question, L. N. Tolstoy noted: "The goal of mathematics is not to teach calculus, but to teach the methods of human thought in calculus", and it is precisely this

knowledge that a person needs in order to live a good life" [4]. It can be argued that Tolstoy proposed the principle of the priority of the developmental function of education as a fundamental principle of the pedagogical system. In other words, teaching physics, mathematics and other disciplines is focused not so much on physical or mathematical education in the narrow sense of the word, but on education by means of these disciplines. In accordance with this principle, specific knowledge is considered not so much as the goal of education, but as the basis for organizing the full-fledged intellectual activity of students. It is this activity, as a rule, that turns out to be more significant for the formation of the student's personality and the level of his development.

The modern school has lost much of the achievements of the 19th century school. First of all, the art of mental arithmetic. Perhaps everyone remembers the painting by the Russian artist N.P. Bogdanov-Belsky (1868 - 1945). He painted genre paintings dedicated to a rural school and peasant children. His most famous painting is "A Difficult Problem", painted in 1895. Now this painting is in the Tretyakov Gallery and is dedicated to the famous teacher and philanthropist S.A. Rachinsky, a teacher, professor of natural sciences, who left the university department to become an ordinary teacher of a rural school. Like L.N. Tolstoy, S.A. Rachinsky cultivated mental arithmetic in his school, based on the virtuoso use of the properties of numbers. In the painting, in the center of the hut, a ten-year-old boy is depicted, pondering over the solution of a problem written in chalk on the board. The problem was indeed difficult:

$$\frac{10^2+11^2+12^2+13^2+14^2}{365}=$$

In Tolstoy's school, great importance was attached to mental arithmetic. There is such a task, attributed to L. N. Tolstoy himself.

A flock of geese was flying, and one goose came towards them.

- Hello, a hundred geese, - the goose says to them.

And they answer:

- There are not a hundred of us, but there would be a hundred if there were that many, and then that many, and then half as many, and then a quarter as many, and you with us.

How many geese were in the flock?

L. N. Tolstoy was just as creative in teaching physics. Actually, he did not have such a subject, but he taught the basics of natural history, and this is beautifully reflected in his "Russian Books for Reading". To understand physics means to be an observant person, to see what others do not notice, to try to find an explanation for everything seen. And Tolstoy follows these principles. He clearly sees the level of knowledge of young children and from this position he tries to find something new in nature and show its beauty and harmony.

What causes wind? The genre of narration itself – reasoning – is designed for joint activity of the student and the narrator and development of observation skills. When we reason, our interlocutor is included in this reasoning, becoming an active observer. This way of studying natural phenomena is non-violent, there are no mentoring instructions, but there is an invitation to creativity. Observation is the first step to creativity. It can be argued that a creative person is someone who knows how to observe. When a child understands what causes wind, he will also understand something else: sometimes we confuse cause and effect. That is why before asserting what is the cause of what, one should reflect and remember a short story-reasoning by L. N. Tolstoy, dedicated to this problem.

Note that much later the student learns that the movement of air masses described by L. N. Tolstoy is called convection, and wind is most often caused by convective currents. The student subsequently learns that the heated room described by L. N. Tolstoy is a simplified model of a heat engine, and our Earth with its storms and hurricanes caused by the movement of powerful air masses is nothing more than a giant heat engine with its own heater, refrigerator and working fluid.

It is curious that in this case we are forced to take a different look at the Sun, the stars, the space surrounding the Earth. The Sun is not only the most familiar luminary, but also the main source of energy coming to the Earth and starting this giant heat engine.

Thus, L. N. Tolstoy's reasoning can be considered as a pedagogical introduction to the physics of thermal processes. The same can be said about most of the works of the great teacher cited here. L. N. Tolstoy's stories are didactically interconnected: each subsequent story is a continuation of the previous one, its development. The story "What is the Wind for?" *(Reasoning)* is presented as such a development.

A student who has understood the origin of the wind should be able to find a useful application for it. After all, someone needs the wind... It turns out that a kite cannot fly without the wind... The author describes the kite's design in detail and at the same time concisely, so that an inquisitive teenager will definitely try to construct this mysterious device on his own.

The wind rotates the wings of mills. As a result, the millstones also rotate and the grain is ground. It turns out that the wind is also involved in the production of flour.

Wind is also used in ships that sail. And this is a sport, and an ancient means of transport, and an object of art, and an object of study from the point of view of physics.

Wind ventilates rooms, helping us breathe fresh air, it plays a key role in pollinating plants. People, observing plants and wind, guessed that it is possible to produce artificial pollination of plants and get a higher yield. The teacher is given the opportunity to find many more useful uses for wind together with the students. But what about the negative consequences of wind, with the raging elements? - These questions are also discussed together with the students. From here - a step to invention.

Heat *(Reasoning)*. The fact that most bodies expand when heated, children learn at school when they study physics. L. N. Tolstoy offers a whole series of propaedeutic stories-reasonings about the nature of heat, about its properties.

The best way to study any phenomenon is with simple observation. L. N. Tolstoy begins his reasoning with an observation: “Why are the rails on a cast-iron (*railway. - V. N.*) laid so that the ends do not meet?” [5, p. 80]. The explanation of this phenomenon is connected with the phenomenon of thermal expansion of steel. Nevertheless, the mystery does not cease to be a mystery. It is easy to see that modern railways often not only do not have a large gap between the rails, but the rails are generally welded into seamless sections, the length of which reaches several kilometers.

And again, let's return to observations. All materials are characterized by thermal conductivity. Introducing this concept at the initial stage is didactically difficult. L. N. Tolstoy starts from everyday observations. Why, when it snows during a thaw, does it melt on your hand, but remain on your fur coat? Why, if you hold a tin mug of cold water in your palms, does the water warm up, but your palms get cold? If you hold a mug with mittens, why does it take so long for it to warm up? Note that the questions are formulated in such a way that any schoolchild can easily conduct his own observation. The author answers the questions posed and immediately asks similar ones: "Why does snow not melt under chips and straw, but remains until the end of the year?", "Why does ice hold up better in cellars under a thatched roof?", "Why, when they want to dry boards, do they put them under an iron roof, not a thatched one?", "Why do men wrap jugs in towels during mowing and reaping, so that the water does not warm up?" Thus, the student discovers a whole class of phenomena that have the same nature. This approach is justified not only at the initial stage of studying physics, but also in senior classes, since it is very important to see in each phenomenon not only the particular, but also the general, what is characteristic of a whole class of phenomena.

L. N. Tolstoy describes magnetic phenomena in his description of "The Magnet", which is perceived as a fairy tale, a touch of a miracle. It turns out that there are stones that can attract iron, and they are found in the ground together with iron ore. The magnetic properties of these stones are transferred to the iron that comes into contact with the magnet. The properties of the magnet are described, allowing us to approach generalizations: the poles of the magnet with the same name repel each other, while the poles with the opposite names attract each other. The compass, which no ship can do without, is also a magnet, or rather, its main part is a magnetic needle, one of whose poles is always oriented to the north. Consequently, the Earth is also a large magnet, because a magnet is attracted only to a magnet.

This is how, step by step, the child gets acquainted with the magnetic properties of matter. Later, he will discover that a conductor through which current flows is also a magnet, and electromagnets with specified properties can be constructed from such a conductor. Some of these magnets are called relays and are used in automation circuits for various processes.

Stories with physical content alternate with other stories, tales, fables, and fairy tales. And again physics: reasoning "Why do windows sweat and is there dew?" The examples given by L. N. Tolstoy reveal the invisible: it turns out that air, like a sponge with water, contains moisture, but it is not visible until the air temperature drops to certain limits. This resembles a compressed sponge: excess water comes out. Without using such terms as "saturated steam", "unsaturated steam", "absolute and relative air humidity", L. N. Tolstoy allows us to understand the origin of dew on the grass and on cold objects brought into a warm room.

Why do trees crack in frost? (Reasoning) The statement that all bodies expand when heated and contract when cooled is, to put it mildly, not entirely true. There are many exceptions to this rule. L. N. Tolstoy shows this only in the third Russian book for reading. For example, water is such an exception. When frozen, water expands and turns into ice. Ice is lighter than water, it always floats on the surface of bodies of water and protects their inhabitants from freezing. Expanding, freezing water is capable of breaking bottles and other vessels in which it is placed. This is one of the mysteries of water - one of the most common substances on Earth.

Thus, from observations the student learns about some properties of water in three states: solid, liquid and gaseous (steam). L. N. Tolstoy generalizes individual observations in the discussion “Ice, Water and Steam”. And here the observation method is the main one. “Ice can be as strong as a rock. If a stick freezes into the ice, you won’t be able to pull it out of the ice until it thaws. When the ice is cold, carts can drive on it without falling through, and if you throw 10 pounds of iron on it, the ice won’t fall through.”

An interesting observation about water: “If you heat the water even more, it will hold even less. It is easier to swim in cold water than in warm water. And even a tree will sink in hot water.” Without being a professional naturalist, L. N. Tolstoy leads students to the idea of the dependence of water density on temperature: as the temperature increases, the density of water decreases (note that this happens starting from +4 °C).

"Warm up the water - there will be steam, cool the water - there will be ice" - this is how the author forms the students' understanding of the three aggregate states of water.

Numerous examples given in the "Russian Book for Reading" help to learn such concepts as the heat capacity of a body and the specific heat of a substance, aggregate states of matter, phase transitions, internal energy, specific heat of fusion, specific heat of vaporization, etc.

Crystals (*discourse*) [5, p. 160]. Together with the author, we observe the world of crystals. They are conveniently obtained in saturated solutions by evaporating the solution or lowering its temperature. Snowflakes are amazing crystals. “A snowflake flies - no figure can be seen in it, but as soon as it sits on something dark and cold, on cloth, on fur, you can make out a figure in it: you will see a star or a hexagonal board. Steam freezes on windows not just anywhere, but as soon as it starts to freeze, it immediately forms a star.” L. N. Tolstoy sees something wonderful in an ordinary snowflake. A snowflake is one of the refined creations of nature. A snowflake can consist of one crystal or a group of crystals. Crystals are formed high in the atmosphere. Where it is warm, they melt and turn into raindrops, and in the cold they retain their graceful shape.

A speck of dust, a grain of volcanic ash, or just a speck of dirt forms the core of a crystal, to which molecules of water are attracted, freezing on its surface. The crystal is carried by the wind through different layers of temperature and humidity, which shape it differently. Snowflakes constantly collide with each other, each time changing their form. When a snowflake finally falls to the ground, traces of its short but stormy life are visible on it - all its scars and beauty. That is why L. N. Tolstoy teaches us to look at a snowflake, to see a lot in it and to be surprised by what we see.

If observation is not trained, this quality will lose its sharpness, and with it the clarity of many phenomena will disappear. Perhaps because of this we sometimes claim that natural sciences are

difficult for us, they are complex. And at the same time, at the end of the 19th century, a contemporary of L. N. Tolstoy, Professor of the University of Edinburgh John Blackie wrote that "all natural sciences should be especially valued not only because they supply our spirit with the richest, most varied and necessary material, but also because they teach us the most useful of all arts - the use of the eyes. It is simply amazing how we all walk with our eyes open and still see nothing! This is because the organ of vision, like all other organs, needs to be developed. Therefore, one cannot help but understand that both in school and at university, natural sciences are recognized as subjects of prime importance, for they teach young people to know what they see and to see what they would not otherwise be able to see."

L. N. Tolstoy comes to generalizations about thermal processes during the transition of a substance from a liquid to a solid phase. “What is ice? It is cold, strong water. When liquid water is made strong, it forms shapes, and heat comes out of it. The same thing happens with saltpeter: when it forms from liquid into strong shapes, heat comes out of it. The same with salt, the same with molten cast iron, when it becomes strong from liquid. When something becomes strong from liquid, heat comes out of it, and it forms shapes. And when something becomes liquid from strong, the thing absorbs heat, cold comes out of it, and its shapes dissolve.”

The fourth Russian book for reading solves more complex problems, they are aimed at using the laws of nature to solve specific engineering problems. We can say that this book has a polytechnic character, helps the student to look at physical laws as a means of transforming the world, using many phenomena to solve practical problems.

In an entertaining way, L. N. Tolstoy introduces students to one of the most ancient laws of physics - Archimedes' law. This law applies not only to immersed bodies in liquids, but also in gases. And since we live at the bottom of a huge air ocean called the atmosphere, all bodies on Earth end up in this air ocean and all of them experience the action of Archimedes' force. Then the meaning of the seemingly absurd phrase becomes clear: "What is heavier: a kilogram of iron or a kilogram of fluff?" - Since weighing is not done in a vacuum, but in air, then when weighing fluff, a much greater Archimedes' force will act on the fluff, therefore, on the balanced scales, the mass of the fluff will be greater than the mass of iron, and the weight of the fluff will also be greater than that of iron.

But if Archimedes' force is comparable to the force of gravity of a body, then such a body is capable of moving in the air. Devices whose operation is based on the use of Archimedes' law in the earth's atmosphere are called airships, aerostats and balloons.

How to make a hot air balloon? L. N. Tolstoy discusses this in his story “How Hot Air Balloons Are Made.” Using boiling water as an example, the author shows how gas bubbles behave in a liquid. “Just as bubbles inflated by volatile water jump out of the water to the top because they are lighter than water, so a bubble inflated by gas – hydrogen, or hot air – will jump out of the air to the very top because hot air is lighter than cold air, and hydrogen is lighter than all gases.” Tolstoy describes in detail a hot air balloon. He recalls the scientific feat of the Montgolfier brothers, who were the first to create such a balloon. In one of their experiments, they tied a ram, a rooster, and a duck to the balloon and let it go. The balloon rose and landed safely. Then they made a boat under the balloon and a man sat in it. Then more people began to fly, they took food and drink with them. By adjusting the amount of hot air in the balloon or the weight of the load in the boat, you can control the flight, ensuring a fairly soft landing of the apparatus.

Following the description of the design of the aircraft, L. N. Tolstoy gives "The Aeronaut's Tale" - a description of a flight in a hot air balloon that will not leave anyone indifferent - neither a student, nor an adult researcher. "The Aeronaut's Tale" seems to sum up the previous story, dedicated to the design features of hot air balloons. The reader feels like a person who has risked rising in a hot air balloon for the first time. It is remarkable that L. N. Tolstoy himself never traveled in this way, but the sensations of an aeronaut are shown so realistically and professionally that one can only be amazed at the writer's observation and his deep understanding of the physical nature of the phenomena described.

The sun is heat *(reasoning*). L. N. Tolstoy forms the idea of universal movement in nature and connects it with heat: “No heat – everything is dead; there is heat – everything moves and lives. Little

heat – little movement; more heat – more movement; much heat – much movement; very much heat – and very much movement." Heat comes from the sun. Tolstoy cites many natural phenomena (snow, movement of steam and water, windmills, growth of plants, animals and man himself), which are entirely determined by the flow of solar energy.

Galvanism (*reasoning*). The author introduces the reader to the basics of understanding the nature of static electricity and tells the story of the discovery by the Italian scientist Galvani of the unusual behavior of dead frogs when electricity is passed through them. Volta continued his experiments. He discovered that the problem was not in the frogs at all, but in the combination of metals. "He tried to bring together iron and copper and other metals and got to the point that from one combination of metals: silver, platinum, zinc, tin, iron - he produced electric sparks. After Volta, they came up with the idea of increasing electricity by pouring different liquids - water and acids - between the metals. From these liquids, the electricity became even stronger, so that it was no longer necessary, as was done before, to rub in order to have electricity; but you just have to put pieces of different metals in one cup and pour in liquids, and there will be electricity in this cup, and a spark will come out of the wire." This electricity was used: "they invented electric light and invented electricity to transmit signs from place to place over a long distance."

In the time of L. N. Tolstoy, these inventions amazed the imagination. One of the first uses of electricity was the invention of the telegraph. The author describes its structure and operating principle as follows. "The telegraph is made like this: electricity is sent along a wire, and an iron post is wound with this wire. And an iron hammer is attached to the overhang above the post. And while the electricity flows along the wire, the iron post, wound with wire, attracts the hammer. As soon as the ends of the wire are moved apart at the other end - even 100 miles away - the electricity stops flowing around, and the iron post ceases to be a magnet and the hammer falls away from it. As soon as the ends are brought together again, the hammer is attracted. And so you can tap with a hammer from one station to another. And signs are arranged by these taps." Undoubtedly, such experiments will arouse the interest of children and the desire to see for themselves.

L. N. Tolstoy gives methodological recommendations to teachers: in order for a student to study well, he must study willingly; in order for him to study willingly, it is necessary:

1) that what is taught to the student is understandable and interesting;

2) that his mental powers are in the most favorable conditions [6, p. 142].

And further - about the role of terminology in teaching: avoid incomprehensible Russian words, words that do not correspond to the concept, or have two meanings - especially foreign ones. Try to replace them with words, even if very long, even if not so precise, but such that in the mind of the student would arouse the corresponding concepts [6, p. 144].

Give the student as much information as possible and challenge him to the greatest number of observations in all branches of knowledge; but communicate to him as few general conclusions, definitions, divisions and any terminology as possible [6, p. 145].

There is no doubt that modern physics and mathematics teachers will again and again make use not only of the methodological recommendations of the great teacher, but also of the examples and observations that he gives.

## REFERENCES

[1] The ABC of Count L. N. Tolstoy. Book I. − St. Petersburg. Type. Zamyslovsky, Bolshoi Meshchan., d. No. 33, 1872.

[2] The New ABC of Count L. N. Tolstoy. Moscow: Typography and Lithography of A. Torletsky and M. Terekhov, Kuznetsky Most, Torletsky House, 1875.

[3] Tolstoy, S. L. Essays on the Past / S. L. Tolstoy. − 3rd ed. − Tula: Priokskoye Book Publishing House, 1966.

[4] Tolstoy, L. N. Pedagogical Works / L. N. Tolstoy; compiled by N. N. Veikshan. − Moscow: Pedagogy, 1989. − 544 p.

[5] Tolstoy, L.N. Collected Works: In 22 volumes. – M.: Art Literature, 1978. – V. 10: Stories and Short Stories. 1872 – 1886 /L.N. Tolstoy.− 1982.

[6] Tolstoy, L.N. ABC; New ABC. / L.N. Tolstoy; compiled by V.G. Goretsky, G.V. Karpyuk.− M.: Education, 1978.− 511 p.