FACTA UNIVERSITATIS
Series: **Teaching, Learning and Teacher Education** Vol. 1, N°1, 2017, pp. 43 - 57
https://doi.org/10.22190/FUTLTE170501005C

Review article

INTEREST IN SCIENCE AND SCIENCE SUBJECTS TEACHING – HISTORICAL PERSPECTIVE

UDC 371.3:3/5(091); 37.01(091)

Dragan Cenić[1], Jelena Petrović[2]

[1]Pedagogical Faculty in Vranje, University of Niš, Serbia
[2]Faculty of Philosophy, Department of Pedagogy, University of Niš, Serbia

Abstract. *This paper represents the attempt of the authors to understand and present, from historical perspective, the interest in natural and social sciences, and especially the interest in introducing their contents into teaching. Thus, the authors analyze the interest in natural and social sciences in Ancient Greek and Roman thought, then in Middle Ages and finally in the 18th and in the 19th century when the solid grounds for science teaching was established. The paper points out to the existence of the first traces of science a couple of thousands years B. C., but the development of science connects to the ancient Greece and its major thinkers who made the first theories about the origin of the world. Further studies of nature were, in the Middle Ages, dominated by the Christian ideology in which the origin of the world and occurrence of living creatures were usually connected to the mystic forces. Only with the development of Renaissance, thinkers put the man and his real life problems in the center of their thought. Only then we can testify the stronger interest in natural sciences. In the circumstances of humanistic shaping of social life, entering of scientific contents into teaching and appearance of scientific subjects came naturally. The Modern Epoch brought the great advances in natural and social sciences. At the same time the demands for introducing scientific knowledge into teaching subjects became more prominent. Special credits for introducing science into teaching and development of methodology of science subjects are paid to the great scientists and thinkers of 18th and 19th century.*

Key words: *science and social science teaching, Ancient Greek and Roman epoch, Middle Ages, Renaissance, Pedagogy, Activity school*

Received May 01, 2017/Accepted May 24, 2017
Corresponding author: Dragan Cenić
Pedagogical Faculty in Vranje, University of Niš, Partizanska 14, 17500 Vranje, Serbia
Phone: +381 17 431-960 • E-mail drcenic@gmail.com

1. INTRODUCTORY REMARKS

Elementary school is one of the highly organized educational institutions in Europe. It was characterized as such during the great part of its history, of course, in keeping with and depending on the development of society and its needs. Teaching subjects and their contents are the most important and the most complex elements of educational process and school organization. Subjects encompassing the themes from natural and social sciences take a very important place among them.

The man developed inside and with the nature, it provided him a shelter, support and knowledge. During time he deepened the knowledge, revealed its laws, faced the truths and rejected biases about it. Nature was an inspiring force for his creative work during the long history of human society. This creative work was a manifestation of a man as a natural, but also as a social being. The man was moved to cooperate with the other human beings, to rely on their mutual help and to relay on the knowledge of those before him if he wanted to make spiritual, material of civilizational advancement.

Those advancements were very important for the cultural history of mankind. First literacy, first teachers and schools and first curricula in old history made the first and basic foundations of culture and enlightment of humankind. Viewed from that perspective, research on the development of teaching and natural and social sciences through historical epochs can be considered important not only for understanding the history of education and teaching, but also for understanding the development of science and culture in general.

Development of teaching natural and social sciences through historical periods was not given enough attention in educational sciences. The main interests in that realm are usually focused on practical contemporary issues, what moved the theoretical and historical perspectives aside. This is the reason we considered that researching the development of science and science teaching can make a great contribution to understanding and improving the natural and social sciences subjects in contemporary curricula.

2. INTERESTS IN NATURAL AND SOCIAL SCIENCES IN THE ANCIENT GREEK AND ROMAN PERIOD

Man as a social being has, during his development, always relied on nature and its inexhaustible resources, strengthened the bounds with it and deepened the knowledge about it. He admired its strength and discovered its laws. This interest for the nature and the world around was initiated by the sole need for survival, but later this preoccupation evolved into creative work and development of scientific and materialistic view of the world. The nature inspired people to be creative, to relay on acquired knowledge to develop the new ones, and the man changed and improved his way of life.

This process of development of man himself and his way of life was hard, complex and long, and it was genuinely connected to activity and work. Friedrich Engels (1951: 138) defined work through wealth, stating that work is the spring of all the wealth but only when taken together with nature because it is nature what gives the resources the work can make into wealth. It means that through work man can make himself, but only if he has nature by his side. Finally, work also powerfully influenced the development of human society because it always had a social meaning.

This development of human society was accompanied by the development of first elements of teaching and education. So, humankind supported its own development by

acquiring knowledge and transferring it to coming generations. In that transfer of knowledge lays the key to accelerated development of humankind and civilization.

The first traces of literacy and studies about nature we can recognize in the ancient civilizations, the cultures that appeared a couple of thousands years before our age, the cultures known as Ancient India, China, Egypt, Babylon and Sumerian civilization (Cenić, Petrović, 2012).

Ancient India had very developed cities a couple of thousands years before our era, in which handcrafts flourished and literacy and knowledge were cherished. Ancient Induses had developed agriculture based on irrigation system. It demanded monitoring the periodical flooding of the rivers, building dams, banks and channels. Science developed from natural needs because economy needed arithmetic, geometry, and astronomy (astrology) and in order to preserve health they needed to develop medicine. All the knowledge was cherished and kept secret by Brahmans (priests) who made it available only to small number of chosen ones (Cenić, Petrović, 2012).

Ancient China as a civilization dates from 2200 BC. It had also developed agriculture, metal coins, and cast iron crafts. Art was also developed, especially bronze modeling, yearbook writing and first inventors appeared. Around the first century BC they used paper and ink for writing which shows the development of technology. For the most learned in the whole China was considered the philosopher Confucius (551 – 479 BC), whose teachings and aphorisms are still appreciated. He was the first private teacher and had his own school founded on the beliefs on the role of nature and society in education.

Sumer, Akkad, Babylon and Assyria are countries embedded in the delta of Tigris and Euphrates. They had highly developed culture and natural sciences, and successfully used astronomy, mathematics and agricultural knowledge. The old Mesopotamian cities had cultivated parks, boulevards, river channels, bridges, roads and luxurious houses for aristocrats. Egypt dates around 5000 years BC. This civilization from the Nile valley had very well developed science, especially natural sciences. Egyptians could forecast the sun and moon eclipse what demanded the high proficiency in astronomy. Prediction of the recovery from an illness were made on the basis of astrology what connects it to medicine

Further development of natural and social sciences is in connection with the flourishing of Ancient Greece, its cities – polises to be punctual. It was the time (6 to 4 century BC) when education gained a special place in society and was put under state supervision. Among the most developed polises Athens stood out with Pericles as its leader. During his reign (the 5^{th} and 4^{th} century BC) philosophy with dialectics developed, natural sciences gained their affirmation and among social sciences history developed.

Some authors (Stanojević, 1920a) who developed methodology of science and social studies subjects analyzed the roots of methodology that can be found in the writings of ancient philosophers. They, for example, explain that History had a great importance for Greek and Roman authors and was studied as a science and taught as a subject. They refer to Plato who starts the education of a soul by telling stories, fairytales and fables, and then starts with reading and writing classes, followed by famous poets, history lessons, music classes and arithmetic. The same author emphasizes that Aristotle did not insist on arithmetic as much as he insisted on history, geography and politics as the means for strengthening moral will.

On the other hand, there are many philosophers who developed natural sciences and were great teachers. Thales of Miletus is one of the Seven Sages of Greece (c. 625 – 528 BC) who was especially interested in natural sciences. He made the ground for philosophy of nature and

made himself famous by predicting the eclipse of the sun. He is believed to have made a several mathematic and astronomic discoveries, and among other contributions, to have transferred geometry from Egypt to Greece. Anaxagoras (500 – 428 BC) was a Greek philosopher, mathematician and astronomer who was exclusively interested in philosophy of nature. He explained sun eclipse and shooting stars as purely physical phenomena. Anaximenes of Miletus (585 – 525 BC) was famous for his belief that the air is the primal element from which everything emerged. He showed the difference between planets and stars. He remained true to the natural sciences. Heraclitus (535 – 475 BC) presented his dialectic view of world and life in a famous writing *On Nature*. He remained famous in the western civilization for his saying *Panta rhei*, meaning everything flows – everything changes and nothing remains in the same state, unchanged. He introduces the notion of evolution in philosophy and believes that the fire is the element of all creation. Democritus (c. 460 – 370 BC) is the maker of atomistic ontology and the philosophy of nature. He introduced the theses that all beings are made of atoms which are physically indivisible particles which differ in shape and size (Cenić, Petrović, 2012). Hippocrates (c. 460 – 377) is one of the most famous Greek physicians, and is referred to as the *Father of Modern Medicine*. He supported the theses that diseases do not depend on the will of Gods, but rather on some real causes and circumstances. Then, we should mention Empedocles (492 – 432 BC) who studied flora and fauna and started systematics as a discipline. He believed that everything in the world consisted of four elements: fire, air, water and earth. Some historical-evolutionists see the seeds of theory of natural selection in his ideas.

Aristotle from Stagira (384 – 322 BC) was the greatest scientist and philosopher of the Ancient Greece. He wrote many studies encompassing the problems of epistemology, politics, ethics, psychology and natural sciences such as biology and geology. He earned a special place among the social scientists, but also among the researchers and experts in the field of natural sciences. He collected all contemporary knowledge on nature, promoted the hypothesis on the emergence of life from nonliving matter, and initiated the study on evolution of the living beings. He systematized the knowledge on about 520 living organisms and organized them into groups, what makes him one of the makers of systematics. He accepted Empedocles' teaching on four basic elements, and added one more that he named aether. He reached the highest reaches of the human mind in the Old Age and was a predecessor of many natural and social sciences (Žderić at al., 1998: 13).

The fields of social sciences in Ancient Greece can proud itself with the giants of Hellenic historiography: Herodotus, Thucydides and Xenophon. Herodotus (c. 484 – c. 424) directed his concept of life and history toward the spirit of Athens' democracy. As a contemporary of Greco–Persian wars, he wrote his life marking work *The Histories*, in which he investigated the facts about the wars. Thucydides (c. 454 – c. 400) continued his history where Herodotus finished and directed his attention to inner conflicts and wrote *The History of the Peloponnesian War*, which is considered by modern historians to be a reliable account of the events, analytically and systematically presented. Xenophon (430/427 – 355) is famous for many historical, philosophical and didactic writings (Cenić, Petrović, 2012: 33-36).

Eratosthenes of Cyrene (276 BC – 194 BC) was a Greek mathematician, geographer, poet, great astronomer in the Alexandrian school, and music theorist. The famous librarian of the Alexandrian Library also invented the discipline of geography, including its terminology used today. He is best known for being the first person to calculate the circumference of the Earth. *Strabo* (c. 63 BC – AD 24) is Greek historian and geographer. Similarly to Herodotus, he travelled a lot and researched and wrote many texts on history and geography. His texts

contained, besides the facts, many explanations and thoughts on geographic objects and events. He believed that geographic surrounding influences the lives of men. Claudius Ptolemy (c. AD 87 – 165) was a prominent Hellenic astronomer and geographer who wrote the first book on geography and invented Ptolemaic World System based on a geocentric theory that was challenged only by Copernicus in 17th century. Roman philosopher Seneca (AD 4 – 65) was also interested in describing the Earth, its development and geologic phenomena (Prodanović, 1972: 13). Pliny the Elder (AD 23 – AD 79) was also a naturalist philosopher investigating natural and geographic phenomena and wrote an encyclopedic work, Naturalis Historia (Natural History) that became a model for writing encyclopedia.

The poet Titus Lucretius Carus (AD 99 – 55) in his famous writing *On the Nature of Things* describes the nature from a clearly materialistic point and takes the stance that world has emerged from indestructible matter. Similarly to Democritus he believed that atoms are in the basis of all things and are permanently moving. Greek physician Claudius Galenus (AD 131–200) was a philosopher and scientist in the Roman Empire. He is the most successful of all medical researchers of the period. Galen influenced the development of various scientific disciplines, including anatomy, physiology, pharmacology, and neurology.

3. Interest in Studying Nature and Human Society in Middle Ages

The decay of the Roman Empire finally ended at the end of the 5th century and the social system based on slavery ended with it. Feudal epoch started with Middle Ages and during its long history brought many and huge social, economic and cultural changes. Basic characteristic of this period is division of society members into estates of the realm of which the nobles had all the military power, shared the political power with clergy and, peasants had no power at all. The church controlled and directed the whole medieval life, often by preaching submissiveness, modesty and asceticism, and promising blissful afterlife for those who did not strive too much in the earthly life.

During medieval period, problems of man and his life were not in the focus of prominent thinkers. Science was considered to be "the maidservant to the theology" (*ancilla theologiae*), natural sciences were under the dominance of Christian ideology and scientific research completely died out or took on mystical features. The church doctrine was not allowed to be doubted and any different opinion was severely punished. The creation of the world and the living creatures was a mystical event and the laws governing the world were God's laws. These trends continued even after 12th and 13th century and the appearance of scholasticism, although it was the official church philosophy which was expected to make amends between religion and philosophy (Cenić, Petrović, 2012).

It was only in 15th century, with the humanism and renaissance movement, that some thinkers from different spheres of life openly moved the man and his life problems back into the focus of their interests. Scientific doctrine of "the God's state", *Civitas dei*, slowly ended and opened the way for researching natural sciences, especially astronomy, physics, anatomy, and physiology. The new ways of manufacture and economy also emphasized the need for research in that realm.

This period testifies the appearance of great and revolutionary scientific discoveries: compass (1302), printing machine (1436), pocket clock (1500), the system of the world (1543), the law of falling bodies (1590), microscope (1590) and telescope (about 1600). Together with the discoveries of America (1492) and the waterway to India (1498) these

discoveries enabled the man new knowledge and new resources and made the further development faster. This new view on the philosophy of nature and growing power of the science over religion could not be suppressed even after the church accused scientists for heresy and persecuted them severely. Giordano Bruno, who was burned at stake for defending his views, became the symbol of new thought and gained the reputation of a martyr for science (Cenić, Petrović, 2012).

This period is also marked with rediscovery of classical Greek philosophy, culture and art. It inspired the rise of many geniuses such as Leonardo da Vinci, Nicolaus Copernicus, Galileo Galilei, Johannes Kepler and many others who made the foundations contemporary natural and social sciences.

Leonardo da Vinci (1452 – 1519) was one of the greatest minds of Renaissance. He was not only a painter, a sculptor and an architect, but an inventor, scientist and thinker. Huge encyclopedic knowledge and his geniality could be recognized in his projects, drawings and sketches. He was not interested only in understanding human body, but also in understanding his psychology, and when it comes to natural sciences, he had special interests in physics, astronomy and chemistry. He was also studying mechanics because he was trying to construct the flying machine. Nicolaus Copernicus (1473 – 1543), an astronomer and professor of mathematics in Rome, but also a monk established a theory of heliocentric system of the world instead of Ptolemy's. It has far reaching consequences on astronomy and other natural sciences and on the progress of humankind in general. Galileo Galilei (1564 –1642), Italian physicist, astronomer and mathematician formulated the law of falling bodies, the power of gravitation and entered the notion of acceleration and later the notion of inertia in science which helped the development of mechanics, which makes him the founder of mechanics. He constructed astronomic telescope that helped discovering many heavenly bodies. In front of the inquisition court he had to renounce his learnings and declare them biases. Johannes Kepler (1571 – 1630) was a German astronomer who defined the laws of planetary movements and proved the validity of heliocentric system of the world. He laid the foundations for the modern astronomy.

Famous mariners with their geographic discoveries made great contributions to studies of nature and society. The most famous of them are: Vasco da Gama, a Portuguese explorer who found the ocean route to India (1497–1499) and connected The East and the West by the sea, then Ferdinand Magellan who organized Spanish expedition which was the first one to circumnavigate the Earth (1519 – 1522) and Christopher Columbus, Italian navigator and explorer, citizen of Genoa who is recognized as a discoverer of America (1492).

All of these and many other discoveries returned the reputation to science and weakened the influence of the church doctrines. They also made the man stronger and more valuable and he regained self-conscience and self-confidence. Natural and social sciences started flourishing and developing new perception of man, science, art and society. These new ideas shaped the character of educational ideas of renaissance and humanistic thinkers.

Humanism in pedagogy was characterized by a great attention towards child as being in development and his psychological traits and specific interests; by respect for its nature and a great care for its complete physical and spiritual development. Humanists promote abandonment of scholastic teaching doctrines, and changing the classical knowledge with the real, introducing mother tongue as the official teaching language in the elementary schools and opening civil schools instead of church schools (Cenić, Petrović, 2012).

In such circumstances, with humanistic ideology shaping the fields of social life, the great achievements of science entered the curricula, natural sciences entered the schools and

new subjects were defined. Humanists confronted new contents of teaching to old medieval ones and firmly demanded from school to introduce and teach subjects that are directly connected to natural sciences, because only such teaching can ensure the development of students' abilities and prepare them for successful life and work (Prodanović, 1972: 14) They emphasized that besides harmonious development and humanistic approach introducing new subjects such as natural sciences and geography was necessary.

Special credits for introducing those new contents in school curricula should be paid to respectful humanists and educators from 16th and 17th century. Special place among the educators who developed real school curricula and humanistic teaching methodology deserve Juan Luis Vives (Ioannes Lodovicus Vives), François Rabelais, Francis Bacon, John Amos Comenius (Jan Amos Komenský) and John Locke. Juan Luis Vives (1492 – 1540) criticized the scholastic school system and reminded that in teaching, it is the things and phenomena that matter, not words (Cenić, Petrović, 2012: 116). He thought that it is important aim in education to make students perceive the phenomena in society and nature and think about them. François Rabelais (1494 – 1553) was a French humanist, philologist, lawyer, and naturalist who studied medicine and natural sciences, one of the most educated people of his time. In his satirical novel *The Life of Gargantua and of Pantagruel* he paints the picture of medieval education and the spirit of medieval life. In the new education he proposes the principle of observation and active involvement, meaning that his student should study botanic by observing the flora and astronomy by observing the skies (*Tabaci iz istroije pedagogije*, 1946: 29). Francis Bacon (1561 – 1626) is the founder of English empiricism and great critic of the scholastic teaching. The most important support for the man comes from the natural philosophy which helps him find and understand natural laws. During the process of learning one should be led by perception and experience, i.e. induction. Bacon recommends studying those sciences that have practical value for the man (Štiglić, 1893: 107). He considers experimenting necessary in order to prove every fact. Only experimentally proven facts should be gathered, ordered, systematized and used for stating theories and rules. True knowledge can be achieved only by induction, and never verbally using names, words and signs (Despotović, 1926: 119). Bacon supports the saying that "Thomas Aquinas derived from Aristotle that there *nothing is in the intellect which was not first in the senses (Nihil in intellectu quod prius no fuerit in sensu)"* (Markie, 2004).

John Amos Comenius (1592 – 1670) is the founder of modern pedagogy and the most important educator of 17th century. He was nicknamed a "Copernicus of didactics" because he instilled revolutionary changes in teaching and gave practical recommendations for studying natural subjects such as nature, geography and mathematics. The real knowledge about nature could not be retrieved from the books. It could not come from the empty words, but from direct observation and active perception of the nature itself. Comenius concluded that there are a couple of didactic principles that should lead every teaching: a) in nature there are things. The children should observe those things through their senses and that is how they form notions. It is very wrong to teach them notions first, and then show them things they heard about; b) The whole of the teaching content will grow out as a live embryo at first, and then develop and grow in accordance with the child's power of understanding; c) The nature of the child is alive and will tend to develop by itself, that is why a teacher should start with what already exists in the circle of child's experience; d) The nature of the child never overreacts or makes huge leaps, it always paces slowly and without leaving empty spaces. That is why the teaching should also pace gradually forward; e) Nature teaches us through its examples, that is why every teaching should find the best

examples in nature and then make generalizations from them; f) Thoroughness lays in constant practice and repeating (Despotović, 1926: 127).

The authors from the 20th century (Janjušević, 1952; Stanojević, 1920b) still look up to Comenius and his recommendations given in his *Didactica Magna* about teaching science subjects. They consider him the founder of methodology of geography and history. He emphasized the necessity of teaching children the most important events in the world through all the grades and levels of school. Similarly, he believes that children should be introduced to geography even in a pre-school period, when they can grasp the basic notions through their senses, for example what is hill, valley, river, town, etc.

John Locke (1632 – 1704) was English philosopher and physician, regarded as one of the most influential of Enlightenment thinkers. His most important writings that influenced pedagogy are: *An Essay Concerning Human Understanding* (1690) and *Some Thoughts Concerning Education* (1693). He is widely known for his belief that the man has no inborn ideas, or pre-existing concepts and that the whole of his knowledge relies on his personal experience. This concept is known as the *blank slate,* or *tabula rasa theory.* This blank slate is written gradually through experience and education. This idea is a continuation of already mentioned Bacon's idea *there nothing is in the intellect which was not first in the senses.* Cognition and knowledge rest upon experience and learning and this makes the understanding of the laws of nature the most important content of education (Despotović, 1926: 157).

4. Strengthening of Natural and Social Sciences in 18th and 19th Century and their Introduction into Teaching

The end of 17th century is marked with gradual ending of feudalism, transferring the political and economic power into the hands civil parliaments and beginning of the Modern Age. Newly developed governing power was gradually consolidating, breaking down the remains of the old social system and introducing new forms of manufacturing and applying many scientific achievements in their economy. This period is a period of great advancement of natural sciences.

The pressure to introduce the new knowledge into teaching also rises. Although educators from the previous epoch insisted on scientific orientation of teaching, it is only in 18th century that they really achieved. New, scientific subjects were introduced into schools in 18th century, first in secondary schools, and later in elementary ones. When science in schools became reality, many educators from 18th century were inspired to shape the subjects and develop methodology of teaching science, and they could realize and prove their ideas in practice. They realized, very soon, that before systematic learning of natural science disciplines, the children should acquaint themselves with their surrounding and get closer to the elements of reality they live in. This kind of understanding reality would help children master scientific notions and systematic knowledge more easily. New school subject that emerged from this understanding got the name *Natural history teaching* (Bezić, 1975: 16). It was gradually developed with all the scientific subjects and disciplines during the 18th and 19th century. In the coming pages we will point out the most prominent and the most meritorious thinkers in this realm.

Carl Linnaeus (1707 – 1778) was a Swedish botanist, physician, and zoologist, who invented the modern system of naming organisms and dedicated himself to systemizing

the all living organisms. This earned him the epithet "father of modern taxonomy" and recognition as the founder of scientific systematics. His work influenced development of natural sciences and taking more comprehensive attitude to studying them, but it also reflected to teaching techniques and content organization in schools. His famous work *The System of Nature* (*Systema Naturae*) indirectly influenced teaching of Biology and Zoology and made it more organized and easier.

Jean-Jacques Rousseau (1712 – 1778), was one of the most important thinkers of the French Enlightment. In opposite to the feudal social system he highlighted the theory of natural rights and social contract which essentially stated that all people are in natural state equal and free, and that they willingly agree to political leadership. In direct relation to this learning he made the theory of natural education which makes the most important part of his educational theory. He believed that education comes from nature, things and people (Cenić, Petrović, 2012: 21), where education coming from things refers to active manipulation of the child itself and education coming from people was adapted to natural needs of the child. So, nature was the main source of learning, it was the wisest teacher and it was supposed to be available to child to take directly from it.

Rousseau believed that the child in the period between 12^{th} and 15^{th} year of its life, is capable to understand the contents of the real subjects, such as geography, astronomy, physics, but not humanistic and social sciences. Natural sciences are supposed to develop curiosity, activity and independence, and the facts are not as important. The child should understand, research and analyze (Cenić, Petrović, 2012: 23). In this period, which is marked with intellectual work and teaching, the child gradually familiarizes itself with the world and its causes and consequences. It does not learn because we told or explained him something, but because it comprehended it. It does not learn science; it comprehends it, because of that learning of geography starts at its home and physics in phenomena closest to it (Despotović, 1926: 165).

While in *Emile* Rousseau's student learns science directly because nature is good in and by itself, about society he has to learn indirectly, because society itself is corrupted and the student should not be exposed to it before he is enough mature and wise. In order to understand people his student learns History. The lessons from history should be simple and correct and the teacher must not impose his opinion about the events. He has to let student estimate and judge the facts by himself (Stanojević, 1920a: 10). Despite some drawbacks Rousseau's thought radically influenced education as a process, but it also contributed to its content and methodology by insisting upon learning from nature as directly as possible and understanding its natural laws.

A group of German pedagogues called Philanthropinists founded the new type of elementary school in 1774 that served as a model for many such schools in Germany. This school was open to science subjects and active methods and tolerance for differences (religious, gender and class) made it famous and appreciated (Kant, Buchner, 1908). The most important educators connected to this school were Johann Bernhard Basedow, Christian Gotthilf Salzmann, Joachim Heinrich Campe and Friedrich Eberhard von Rochow. Curriculum included classical and modern languages, philosophy, ethics, arts, natural sciences, history, geography and mathematics and active learning methods directed students toward independence (Cenić, Petrović, 2012: 38). It inspired changes in secondary schools where natural sciences gained even more space and the schools were named *real schools* after the group of subjects containing scientific, i.e. real knowledge. Those subjects were geography, natural sciences and history, and they were studies 6 to 8 years (Cenić, Petrović,

2012: 39). Philanthropinists developed active and interesting methods of teaching, tried to respect the principle of observation and whenever possible they presented students the studied phenomenon or presented the illustration of it, and in studying history they were telling stories and elaborating unfamiliar notions. They often connected history and geography and used historical and geographic maps (Cenić, Petrović, 2012: 31; Stanojević, 1920a: 11).

Johann Heinrich Pestalozzi (1746 – 1827) the famous Swiss educator who introduced the introduction to nature as a separate subject of the elementary school and elaborated the use of principle of evidence-based teaching. Explaining the importance of this principle for learning in his famous work *How Gertrude teaches her children* (1801) he says that only the truth that comes from evidence-based teaching gives man the power to prevent prejudice and bias to enter his soul. Under evidence-based he understands not only visual perception, but the involvement of all senses, because the more senses are involved in learning the more thorough the knowledge will be (Cenić, Petrović, 2012: 56). He elaborated the separate teaching methods for different subjects because he widened the scope of contents and divided natural sciences and geography (which contained some knowledge rom geography, history and introduction to nature). In teaching methods he respected the didactic principle of graduality, which in example of geography means that he started with observation and familiarization with the near surrounding, then with observation the landscape and finally he moves to using the maps (Cenić, Petrović, 2012: 58).

English social-utopists made a great contribution to development of natural sciences teaching. Robert Owen (1771 – 1858) showed a great interest in organizing teaching the introductory contents of natural sciences in the elementary school. The children between 6 and 10 years old learned reading and writing, arithmetic and basics of geography and history, and in the afternoon schools for children between 10 and 17, the basics of mechanics and natural sciences were thought. Owen started with the system of half work – half school for the children in his factory and connected teaching to child labor (Zaninović, 1988: 188). He organized teaching that didn't support mechanical learning without understanding and asked teachers to develop children's interests by organizing evidence-based teaching especially for natural sciences (field trips, maps etc.). His naturalistic institute had natural museum with the pictures of plants and animals and with a botanical collection.

Among the most prominent educator of the 19th century is German philosopher, psychologist and mathematician Johann Friedrich Herbart (1776-1841). His name is associated with the act of scientific recognition of pedagogy as a science because he defined its firm philosophical and methodological foundations. He also elaborated didactics and teaching methods and articulated the whole teaching process up to the level of inner structure of a class. Although the main aim of education is perceived as building and strengthening the moral will, social and natural sciences have a valuable place in his educational system. They, in fact serve the main aim in the best way, especially history for which he gives many recommendations. He believes that teaching history serves intellectual and moral development and wakes different interests. His recommendations for teachers refer to using original texts; not to be too exhaustive, because in that way they can lose themselves in data and walk away from the aim; to explain the notions and connect them to the contents; to teach as clearly and as simply as they can and to use maps, even more often than the pictures (Stanojević, 1920a: 12).

German pedagogy of 19th century offered the history of education also very significant figures in the names of Friedrich Froebel (1782 –1852), the founder of kindergartens and Adolph Disterweg (1790 – 1866) who fought for professionalization of teaching and had a

very valuable impact on education of teachers; and for the autonomy of schools, especially in the sense of freedom from religious doctrines. Froebel was inspired by Rousseau in his understanding the relation between man and nature and consequently nature takes the significant space in his teaching. He believed in the concept of the general connection of everything that exist which transferred to teaching means that a child should be educated to realize itself as part of nature and to conceive the nature around as a whole at first, and then its parts. Although his main work is focused on pre-school children the first activities planned for the children are play and gardening. He believed that gardening will help children realize the interconnectedness and cyclic nature of the world and that it will feel as part of it. Only after that, the interests to study nature will appear and the child will be ready to study natural sciences as physics or chemistry, and finally the child should study nature from nature itself, and not in the school rooms (Cenić, Petrović, 2012: 56; Zaninović, 1988: 172). Disterweg, on the other hand was focused on the population of teachers, believing it to be the way of influencing the whole system. In order to teach the introduction to natural studies in elementary schools, teachers had to understand the phenomena, facts causalities and laws of nature. Because he had the importance of natural subjects in mind, Disterweg put natural sciences at a very high position in teacher education. He claimed that education of teachers has to be in keeping with the spirit of the time, and its main goal is to widen the natural-scientific knowledge of the teachers. And by that, he does not understand the knowledge about mineral, plants and animals, but understanding the laws and phenomena in nature (Rotenberg, 1941: 10).

Besides the great educational theorists who emphasized the importance of studying nature, there are many educators in the 19th century who were developing teaching methods and teaching skills, building systems of methods and principles, and finding the most suitable ways of application the scientific contents in teaching. Naturally, there were differences in conceptions and many authors developed different methodologies, resulting in different organization of teaching in the realm of basic teaching of natural sciences contents. Among the authors who developed methodology of natural science teaching in the 19th century, the following names stand out: August Lieben, Friedrich Junge, Otto Schmeil and Wilhelm Lay.

August Lieben (1804-1873) is amongst the first teachers to elaborate the teaching of introduction to nature as elementary school subject, and to elaborate the detailed organization of individual school classes. He presented his methodology in the work *Natural History for Children and Public Schools* where he starts with the basic orientation that teaching should enable children to observe nature independently and by themselves, and it should follow the well-known and proven road of pacing from nearer and familiar towards general. He recommends, except observation school trips and excursions, work in the school garden, drawing, studying the way of life and development and natural laws (Prodanović, 1972: 16). The aim of teaching natural history is introducing students with the living world and unity of nature, he recommends students to become familiar with their birth place, and then with other natural, geographic and historical environments. Similar principles are supported by Friedrich Junge (1832 – 1905), who wrote the book *Village pond as a living community*. He believes the nature can be understood first by understanding living communities, which are always regulated by the laws of the nature. The way of studying nature should flow gradually from individual examples, their smaller communities which are available to students, then putting them in context of larger communities and finally comes to understanding the life on Earth. That makes the main goal of natural history – understanding the unity of life in nature. The

real knowledge of nature comes from understanding the development and sustaining nature, from understanding that every organism is unique and separate, and that every organ in one organism is connected to other organs in it; and that there is a great similarity between the relations among organs inside one organism and organisms within the living world. In addition, he emphasizes the need to study nature by understanding mutual relations between living and non-living natural world (Prodanović, 1972: 17).

Otto Schmeil (1860 – 1943) is remembered for his reform efforts in regards to biology education. He was a German zoologist, botanist and educator, and expert in teaching natural sciences. He exposed his ideas in a study *On reform efforts in the areas of natural history instruction.* Natural history should be studied in accordance with basic biological principles, meaning that we should start with morphological and physiological observation of the living creatures and continue to systematic biological observations. He does not support descriptions and classifications in natural history. His orientation is expected to help students focus on connections in nature that would lead to understanding the main laws in natural phenomena. He believed that elementary teaching is the best if it presets facts and lets students induce conclusions, for this process makes the foundation for understanding complex laws in the higher levels of schooling. He highly appreciated the use of the school garden and evidence-based teaching (Prodanović, 1972: 18)

Another educator who aspired towards the reform in the methodology of teaching natural history is one of the founders of experimental pedagogy Wilhelm Lay (1862 – 1926). He explained his views in *Methodology of natural history teaching and criticism of the reform efforts on the basis of the new psychology.* Lay believed that teaching science should be based on experience and not on philosophical-speculative thinking; the aim was to use experiment, statistics and accurate or systematic observation in deciding methods. The effects of teaching should be verifiable through didactic-psychological experiments and should lead towards the improvement of school practice and teacher training. He also emphasized that teaching natural history should be in accordance with the theory of evolution, and allows for the dualism between religious and scientific elements of teaching.

The end of 19^{th} and beginning of 20^{th} century are marked with new pedagogical approaches and the educators working at the turn of the century are introducing new methods and enriching curricula with practical and life connected contents. Darwinian ideas entered teaching practice and didactic and methodological theory. Teaching was supposed to help students build a belief that all natural phenomena are in essence of material nature. That belief was achieved by using practical work that was not only meant to be the aim of activity, but it was a tool for reflecting natural phenomena into knowledge, skills and habits of the students (Grindić et al., 2001: 16) Such scientific conception of the living world changed natural history teaching and its place in education. This great change was attributed to by Activity school proponents who placed work and activity in the center of educational work. German educator and theorist of activity school or work school (*die Arbeitschule*) Georg Kerschensteiner (1854 – 1932) fairly influenced popularization of natural history teaching and development of methodology of natural and social sciences teaching. He put the scientific knowledge in the service of work and efficacy of teaching process which had a manual orientation. In addition to the introduction of child to basic knowledge about physics, chemistry and other sciences, Kerschensteiner set up wood and metal workshops, school kitchens and school gardens in which children could apply those knowledge. According to him, educational work had to be coined manually, practically and mentally at the same time. This orientation was widely accepted by the learned men in Serbia.

Activity school had a couple of variants that deferred in their conception of the work, but all of them closely connected natural sciences with the activities of the child, we can even say subordinated them to the child's activity. Practical activities of dealing with plants and animals, aquariums and terrariums, caring for school garden, cooking or building were always supported by scientific content, but always given priority over them. This was because the activity school supporters believed that the best way to ensure the right observation and understanding of natural phenomenon is to use it oneself in practical projects, modeling, drawing, experimenting and by working in school laboratories, garden, aquariums etc.(Cenić, Petrović, 2012; Prodanović, 1972: 19).

The end of the 19th century was marked with the reform efforts of the natural and social sciences teaching and especially the natural history teaching. Those efforts were mainly focused on the students' needs and attempts to enable development of students' abilities to understand the casual relations in nature and society, and to understand the reality of life as perpetual movement, change, overcoming obstacles. These orientations changed the place of natural and social sciences in schools, but strengthened the materialistic bases of teaching them.

5. Final Remarks

Elementary school with its structure and educational role, teaching subjects and their contents represents the key institution of the whole educational system. Teaching of the social and natural sciences content takes a very important place inside that system. This paper monitors the changes of the role and place of natural sciences and their teaching that took place during the long historical period starting with the first organized educational work and ending at the beginning of the 20th century with the rise of contemporary pedagogy.

In the process of learning and discovering laws of nature and society, man has constantly evolved, starting with the first discoveries and the domestication of animals, to the industrialization and automation. The first traces of literacy and natural studies are found in the oldest civilizations, in countries that are created thousands of years before our civilization, such as India, China, Egypt, Babylon or Sumerian civilization. These countries had highly developed cities, crafts, literacy and a great knowledge of nature. Many sciences were highly developed, and above all natural sciences, of which to astronomy, astrology and medicine belongs a special place.

Further development of natural and social sciences is linked to ancient Greece and its thinkers and philosophers. All of them contributed to the development of science, each in their own way. They expressed their opinions about the origin of life, studied astronomy, medicine, geography, some of them tried to systematize plants and animal species, explain evolution, or make a significant contribution to historiography as Thucydides, Xenophon and Herodotus. We also paid attention to the scientists such as Pliny the Elder, naturalist philosopher who investigated natural and geographic phenomena and wrote an encyclopedic work that became a model for writing modern encyclopedia and Claudius Galenus who influenced the development of various scientific disciplines, including anatomy, physiology, pharmacology, and neurology.

The study of nature in the Middle Ages was strongly influenced by the Christian ideology. According to the religious teachings, the origin of living beings is related to the

mystique force and is not to be studies or questioned. This trend was partially stopped in the 12th and 13th century with the development of scholasticism which connected religious teaching and scientific opinion, and tried to reconcile reason and religion.

During the Renaissance large and revolutionary scientific discoveries appear. This caused the unstoppable rise of brilliant people who laid the foundations of modern natural and social sciences. We named only some them: Giordano Bruno, Galileo Galilei, Johannes Kepler, Nicolaus Copernicus, Leonardo da Vinci, Ferdinand Magellan, etc. With their discoveries in the field of natural and social sciences they struck the foundations of the church and its ideology and restored the reputation of science. Natural and Social Sciences in the epoch of humanism and the Renaissance flourished and made a ground for development of the new look at the man, science and art, and these new orientations characterize the epoch of the Renaissance and influence the pedagogical ideas of humanists.

In such circumstances, in which humanism shaped all the fields of social life, the great achievements in the field of science, naturally, strongly influenced education. Natural sciences entered educational practice and the new subjects emerged. Distinguished representatives of humanist pedagogy, such as Juan Luis Vives, François Rabelais and Francis Bacon, until the end of the 17th century, made great efforts to instill the new content in the curricula and enable penetration of scientific achievements in schools. In spite of their efforts, and especially efforts of John Amos Comenius, these new subjects and contents are introduced in schools only in the 18th century. They first entered middle schools, and then elementary schools.

The end of the 17th century marks the end of the feudal era and the beginning of the era of the modern age. In this period (18th and 19th century) science experienced major breakthroughs. At the same time with the development of natural sciences, there are also requirements for their introduction into teaching. Outstanding contribution to the development of natural sciences and their introduction to teaching and methodical thinking are associated with the great educational thinkers and scientists of the 18th and 19th centuries. Among others we mentioned: Carl Linnaeus whose dedicated work to systemizing all the living organisms reflected on teaching techniques and content in schools; Jean Jacques Rousseau who praised the knowledge of nature and demanded nature and natural sciences to have an important place in education; German Philanthropinists: Basedow, Salzmann, Campe and von Rochow who emphasized the necessity of school education to be linked with life and argued that the instruction should be based on experiments; The giants of German classical pedagogy: Pestalozzi and Froebel who argued the importance of connecting children with nature and stressed the need to connect teaching and work, and Disterweg who insisted on teachers studying natural sciences and explore its phenomena and laws in order to be able to present them in teaching.

Among the authors who dedicated to developing methodology of natural science teaching in the 19th century, we mentioned August Lieben and Friedrich Junge who elaborated a detailed natural history teaching methodology and Otto Schmeil and Wilhelm Lay, who took more of a reformist stances, did not support descriptions and classifications in natural history and philosophical-speculative thinking, but believed that teaching science should be based on experience and systematic observation.

In the 18th and especially the 19th century, educators and methodologists definitely agreed that students in the first years of primary school have to be introduced to elementary knowledge about nature and society. Pre systematic teaching of history, geography and natural sciences is necessary and it starts in the students' immediate environment. Afterwards the teaching should aim at the development of students' abilities to understand the casual

relations in nature and society, and to understand the reality of life as perpetual movement, change and overcoming obstacles. The orientations from the beginning of the 20th century changed the place of natural and social sciences in schools; strengthened the materialistic bases for teaching them and opened the way for new approaches in the contemporary era.

REFERENCES

Bezić, K. (1975). *Metodika nastave prirode i društva.* Zagreb.
Cenić, S., Petrović, J. (2012). *Vaspitanje kroz istorijske epohe, knjiga prva i druga.* Vranje.
Despotović, P. (1926). *Istorijska pedagogika*. Beograd.
Engels, F. (1951). *Dijalektika prirode*. Beograd
Grdinić B. i sar. (2001). *Metodika poznavanja prirode*. Sombor.
Janjušević, M. (1952). *Metodika nastave zemljopisa u osnovnoj školi*. Beograd.
Kant, I. & Buchner, E F. (1908). *The educational theory of Immanuel Kant*. Philadelphia & London: J.B. Lippincott Company.
Markie, P. (Fall, 2004 Edition). "Rationalism vs. Empiricism." *The Stanford Encyclopedia of Philosophy*. Edward N. Zalta (Ed.). Retrieved March 28, 2017 from https://plato.stanford.edu/entries/rationalism-empiricism/
Prodanović, T. (1972). *Metodika nastave poznavanja prirode*. Beograd.
Rotenberg, V. (1941). *Disterveg o učitelju*. Biblioteka „Budućnost", sv. 79, Beograd.
Stanojević, M. (1920a). *Metodika istorijske nastave u narodnoj školi*. Beograd..
Stanojević, M. (1920b). *Metodika zemljopisne nastave u narodnoj školi*. Beograd.
Štiglić, M. (1893). *Povjest pedagogike*. Zagreb.
Tabaci iz istorije pedagogije (1946). Beograd.
Zaninović, M. (1988). *Opća povijest pedagogije*. Zagreb.
Žderić, M. i sar. (1988). *Poznavanje prirode u nastavnoj teoriji i praksi* Novi Sad.

ISTORIJSKI PRISTUP INTERESOVANJU ZA NAUKU I NASTAVU O PRIRODI I DRUŠTVU

Rad predstavlja pokušaj da se ukaže na to kakvo je bilo interesovanje za prirodu i društvo u antičko-grčkoj i rimskoj epohi, zatim na interesovanje za proučavanje prirode i društva u srednjem veku i na utemeljivanje prirodnih i društvenih nauka u 18. i 19. veku i njihovo uvođenje u nastavu. U radu je ukazano na prve tragove civilizacija stvorene nekoliko hiljada godina pre nove ere, da bi se dalji razvoj nauke vezao za antičku Grčku i njene mislioce, koji su davali svoja mišljenja o postanku života i evoluciji. Proučavanje prirode u srednjem veku bilo je pod snažnim uticajem hrišćanske ideologije, gde se postanak živih bića vezuje za uticaj mističnih sila. Tek se u periodu renesanse pojavljuju mislioci, koji u centar svojih razmišljanja stavljaju čoveka sa njegovim životnim problemima, pa se prirodno javlja snažnije interesovanje za realne nauke. U takvim okolnostima, kada humanizam oblikuje sva polja društvenog života, prirodno je da velika ostvarenja u oblasti nauke snažno utiču na nastavu, na uvođenje sadržaja prirodnih nauka, kao i na pojavu novih nastavnih predmeta. U periodu moderne epohe prirodne i društvene nauke doživele su veliki napredak. U isto vreme javljaju se i zahtevi za njihovo uvođenje u nastavu. Posebna pažnja u radu poklonjena je velikim misliocima i naučnicima 18. i 19. veka koji su imali izuzetne zasluge za razvoj nauka i njihovo uvođenje u nastavu, kao i za razvoj metodičke misli nastavnih predmeta društvenih i prirodnih nauka.

Ključne reči: *nastava o prirodi i društvu, antičko-grčka i rimska epoha, srednjovekovna epoha, renesansa, pedagogija, radna škola.*