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IBI (India) = 4.260
OAJI (USA) = 0.350

SOI: [1.1/TAS](#) DOI: [10.15863/TAS](#)

International Scientific Journal
Theoretical & Applied Science

p-ISSN: 2308-4944 (print) e-ISSN: 2409-0085 (online)

Year: 2020 Issue: 12 Volume: 92

Published: 23.12.2020 <http://T-Science.org>

QR – Issue



QR – Article

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**ON INCREASING THE EFFECTIVENESS OF CLASSES IN PHYSICS BY
DEMONSTRATING HISTORICAL-FINANCIAL SYMBOLS**

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Abstract: The article deals with one of the methods for increasing the effectiveness of classes in physics. To improve the efficiency of classes in physics, it is proposed to use a new teaching method - the method of "demonstrating historical-financial symbols". The principle of the method is to demonstrate the historical-financial symbols (banknotes), in which physicists-scientists are depicted in the study of physical phenomena and the laws related to their names. Organizing physics classes in a such way could motivate young people and increase their interest in physics. The method can be used as in lectures, practical and seminar lessons in physics as well as in extracurricular activities in physics.

Key words: physics, teaching methods, historical-financial symbols.

Language: English

Citation: Yavidov, B., et al. (2020). On increasing the effectiveness of classes in physics by demonstrating historical-financial symbols. *ISJ Theoretical & Applied Science*, 12 (92), 263-272.

Soi: <http://s-o-i.org/1.1/TAS-12-92-52> **Doi:**  <https://dx.doi.org/10.15863/TAS.2020.12.92.52>

Scopus ASCC: 3304.

Introduction

Over the past years, historical reforms have been conducted in the educational systems of the countries (Cerych, 1997; Garrouste, 2010; Hall et al., 2020). In accordance with the requirements of the modern educational technologies for each subject advanced pedagogical methods, modern information and communication technologies are used on the basis of the curriculum, syllabus recommended by the experts, competent councils and approved by competent educational authority. While conducting the lessons according to the lesson plan it is important to take into account the specifications of each subject, especially for the explanation of each topic a particular method should be chosen; admittedly, it is more important than ever according to most educators. However, there is a method that can be applied in a general, traditional and universal way, which is still used effectively in the era of new pedagogical technologies. This method is about the method of using symbols (pictures, photographs, postage stamps, etc.) that reflect the image of individuals who have worked in scientific field and made great contributions to humanity with their discoveries. This article describes a method that has not yet been used in teaching physics, but if it is used, it can be very effective which is based on the use of historical-financial symbols. Increasing student's interest in physics by using historical aspects of science, in particular, teaching the history of science in physics classrooms was discussed in Ref.(Demirci, 2016). The method that we would like to discuss here is based on historical-financial symbols and was first proposed quite recently in Ref.(Yavidov, 2019). The method does not cover the entire learning and teaching processes, but along with other methods, it is used to supplement the information given in the textbooks in a short period of time, to further strengthen the acquired knowledge and thus increasing the effectiveness of the lesson. The method can be applied in all types of physics lessons (lectures, practical lessons, seminars, experiments) of all sections and extracurricular activities in physics as well.

2. The method

Usual physics classrooms are equipped with portraits of great physicists in educational institutions. In chronological order starting from ancient time to the present, these paintings are dated from the period of ancient Greek philosophers such as Ptolemy, Aristotle, Archimedes, Plato and others. In the next place some paintings of scientists, who lived in the Middle Ages and made significant contributions to the development of physics and astronomy, are visible. For example, in Uzbekistan, pictures of of great ancestors, such as Abu Ali ibn Sino, Abu Rayhan Beruni, Al Farabi, Umar Khayyam, Al Tusi, Mirzo Ulughbek, who lived and worked in Central Asia from the beginning up to the middle ages of the second millennium, also appeared in the classrooms after independence. As physics was developed on the European continent in the later period, in the Middle Ages, the majority of physicists of that time were from the European continent, these people are Isaac Newton, Robert Hooke, Blaise Pascal, Ivanjelista Torrichelli, Huygens, Fresnel, Leonid Euler, and others. The portraits of great physicists of the XIX-XX centuries Wilhelm Roentgen, Alexander Stoletov, Albert Einstein, Maria Skladovskaya Curie, Kamerlingh Onnes, Nils Bohr, Ernest Rutherford, Chadwick, Lev Landau, Peter Kapitsa, etc., are in the physics room too. In short, the physics classroom is equipped with portraits of great physicists and is used for educational purposes. For example, during the dynamic's session, students become familiar with Newton's laws. In order to make the lesson more interesting and to keep the knowledge in the student's memory, the teacher can adjust the interesting information about Isaac Newton's life (Golub, 2002) and show the students the portrait of Isaac Newton on the wall of the classroom. While explaining the other topics the portraits of physicists related to laws or rules of the subject are presented. "It is better to see once than to hear a thousand times", this proverb in teaching will ensure that the lesson is effective. It is possible to further increase the effectiveness of the course. For the implementation of this, we recommend the method that has not yet been used in the lessons of physics. This method can be called the "The use of Historical-Financial Symbols" method (Yavidov, 2019). The

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essence of the method is as follows: in addition to the portraits of scientists related to the laws and rules on the subject, the role of these scientists in society, their exemplary personal qualities, the recognition and application of their inventions are discussed. The most important aspect of the method is to emphasize and demonstrate that the work of scientists has been valued, and as a symbol for this, the image of scientists is reflected on the currencies of country. The great services rendered by physicists to their people are appreciated, and their image is reflected on the currencies of nations.

3. Physics on historical-financial symbols

The followings are examples of some physicists (in arbitrary order) being portrayed on some government financial banknotes.



Figure 1. The image of frontside of 1 pound (1978-1984) .

Michael Faraday (1791-1867)

He is the English physicist, who was the first to dilute chlorine in 1824. In 1837 he introduced the concept of dielectric constant in science. He made a

great contribution to the science of physics by introducing similar indescribable innovations into science. The image of the scientist for his great services was printed on state money banknotes. The £ 20 money with the image of Michael Faraday was used for sixteen years, from 1990 to 2006.



Figure 2. The image of the frontside of £ 20 of UK.

Carl Friedrich Gauss (1777-1855)

He is a German physicist and mathematician, who discovered the laws of electric field induction current

for an electrostatic field with M.Ostrogradsky (1801-1862). He co-founded the first electromagnetic phone with W.E.Weber (1804-1891). For his services, his country printed his image on the national currency in his honor.

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Figure 3. The image of 10 Deutsche mark banknote of Federal Republic of Germany (nowadays it is outdated).

Erwin Schrodinger (1887-1961)

The Austrian physicist Erwin Schrödinger is one of the founders of quantum mechanics. He developed the

wave theory of matter. In 1983, a banknote of 1,000 shilling with Schrödinger portrait was issued in Austria. They were used until the country’s transition to the EU currency.



Figure 4. The image of 1000 Schilling of Austria.

Albert Einstein (1879-1955)

A.Einstein is a German physicist who theoretically explained the laws of the photoelectrical

effect (in brief “photoeffect”) and motion of Brownian particle. He is also famous as the founder of the theory of relativity both special and general. Einstein’s image is depicted on a 5-shekel banknote of the Israeli state banknote (Figure 5).



Figure 5. The image of 5 Shekel of Israel.

William Thomson (1824-1907)

Sir William Thomson is British physicist and engineer, born in Belfast. Thomson is famous by his research and discoveries in the of thermodynamics, and in particular, by his work on the mariner’s compass. He

was ennobled in 1892 in recognition of his achievements in thermodynamics becoming 1st Baron Kelvin. Absolute temperatures are stated in units of kelvin in his honour. The portrait of Lord Kelvin is depicted on frontside of 100 pound of Scottish banknote.

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Figure 6. The image of 100 pound of Clydesdale Bank (Scottish Bank).

James Watt (1736-1819)

He is a Scottish inventor. In 1784, he invented the economical and efficient universal steam engine. Saturated vapor pressure was checked for the type of substance. He improved the steam engine, developed a

mechanism for the transmission of piston motion, introduced a unit of horsepower, developed a symbolic monometer, a symbolic vacuum gauge pressure indicator. In the system of international units, the unit of power is named in his honor. The England 50-pound coin depicts James Watt co-starring Matthew Bolton (Figure 7).



Figure 7. The image of frontside of £ 50 of UK.

Niels Henrik David Bohr (1885-1962)

He is a Danish scientist. He is best known for his work on theoretical physics, especially atomic physics.

His image was printed on a 2002 Danish 500 kroner note (Figure 8).



Figure 8. The image of 500 Kroner of Denmark.

Ernest Rutherford (1871-1937)

He is a British physicist from New Zealand, a British colony. The founder of atomic and nuclear

physics, proposed a planetary model of the atom. His image is printed on New Zealand's 100 dollar (Figure 9).

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Figure 9. The image of 100 dollar of New Zealand.

Galileo Galilei (1564-1642)

He is an Italian physicist and astronomer. He was the first to study the laws of plane motion, free fall, the

motion of an object in an inclined plane, the motion of a pendulum, the addition of forces, the relativity of motion, the addition of velocities. His image was printed in 1973 in 2000 Italian lira (Fig. 10).

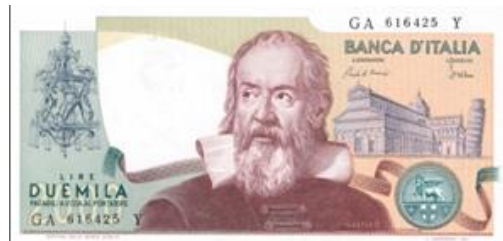


Figure 10. The image of Italian 2000 Lire.

Alessandro Volta (1745-1827)

A. Volta is an Italian physicist and physiologist. In 1775 he invented the electroscope, and in 1781 the

electrometer. In honor of this the portrait of Volta was embodied on the fronside of 10,000 Italian Lira. This currency was introduced in 1984 and had been valid until Italy joined European Union (Figure 11).



Figure 11. The image of Italian 10000 Lire.

Blaise Pascal (1623-1662)

He is a French mathematician, physicist and philosopher. His work is devoted to hydrostatics. The basic law of hydrostatics, known with his name as Pascal's Law, was stated in 1653. He discovered the

principle of hydraulic press functioning as well as he proved the existence of atmospheric pressure. In the International System of Units the unit of pressure is called in the honor of Pascal. The French government reflected the image of Blaise Pascal on its 500 franc coin issued in 1977 (Figure 12).

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Figure 12. The image of French 500 Franc (1977 y.).

Christiaan Huygens (1629-1695)

He is a Dutch physicist, mechanist, mathematician, astronomer. In 1657 he was the first to

invent a pendulum clock. He was a supporter of the wave theory of light. The image of Huygens is printed on a 25 gulden currency (Figure 13).



Figure 13. The image of 25 gulden currency, Netherlands.

Maria Sklodovskaya-Curie (1867-1934)

She is a French physicist and chemist. She was born in Poland. She studied the phenomenon of

radioactivity. She and Pierre Curie discovered new radioactive elements Polonium and Radium. For the works in the field of radioactivity they won the Nobel Prize in 1903. On the French currency, introduced in 1989, their images were printed (Figure 14).



Figure 14. The image of French 500 Francs (1989 y.).

Maria's grandiose achievements were also recognized by her homeland, Poland. Sklodovskaya-

Curie is featured on the front side of 20,000 old Polish Zlotych banknote which was issued by The Narodowy Bank Polski in 1989 and was valid until 1996.



Figure 15. The image of French 500 Franc (1977 y.).

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Nikola Tesla (1857-1943)

He is Serbian electrician. He made several inventions in various fields of electrical engineering. Multiphase generators, electric motors, transformers, multiphase current distribution schemes and so on. In

the honor of his services, the Yugoslav government printed image of Nikola Tesla on its currency. His images have been printed not once but five times on various banknotes. In particular, his image can be seen on the 5, 100, 5000000 and 10000000 dinar coins that have been in circulation over the years (Figure 16).



Figure 16. The image of Yugoslav 5 dinar (1994 y.)

Benjamin Franklin (1706-1790)

B. Franklin is an American statesman, who played a significant role in the struggle of North American colonies for independence, participated in the drafting of the US Constitution, opposed slavery and oppression of blacks. It can be argued that “America made her first contribution to physics in the very important work of Benjamin Franklin” (Bumstead, 1921). Apart from social and political activities

Franklin used to study some physical phenomena, in particular, static electricity and hot-air balloon motion. He was sure that almost all the phenomena of electricity could be explained in terms of a repulsive force between the small weightless particles of the electric fluid and a counter-force of attraction between the particles of the fluid and those of ponderable matter (Buchwald and Fox, 2013). It is believed that he was also one of American physicist-theoreticians and meteorologist. Nowadays, Benjamin Franklin is portretted on 100 US dollar banknote.



Figure 17. The image of Benjamin Franklin on 100 US\$.

The financial currencies mentioned above, in which the famous physicists are depicted, are not isolated cases, but are common in other parts of the world. Printing great ancestors' image on public

money is common not only in European countries but also in the Eastern ones. For example, on the one tenge currency of the Republic of Kazakhstan, introduced in 1993, the image of the great encyclopedic scholar Abu Nasr al-Farabi (873-950) was embodied (Fig. 18).



Figure 18. The image of 1 Tenge (1993 y.), Republic of Kazakhstan.

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Al-Farabi can be considered the ancestor not only of the Kazakh nation or the people of Kazakhstan, but also of all Turkic peoples. Being an outstanding philosopher, he became known as Al-Mu'allim as-Thani or "the Second Teacher - Aristotle of the East".

He is the author of more than 160 works on mathematics, astronomy, medicine, music, philosophy, linguistics, and literature. Al-Farabi introduced the concept of "empty space" (void) to science (McGinnis, 2018). The 1 tenge currency of Kazakhstan was valid until 2012.



Figure 19. The image of Armenian 100 dram(1998 y.).

Similarly, the world-renowned Armenian astrophysicist, founder of the Byurakan Astrophysical Observatory (1946) and inventor of stellar associations (1947) (Lankford, 2013) V.A.Ambartsumian is embodied on the 100 dram banknote of the Republic of Armenia. The 100 dram was introduced in 1998 and is valid at present.

Quite recently, in 2019, Uzbekistan embodied the image of Mirzo Ulghbek (Ulugh Beg) on the frontside of its 100000 so'm. Mirzo Ulughbek was the sultan (the ruler) of Samarkand during (1394-1449) and at the

same time he was one of the greatest astronomers of the middle ages. Ulugh Bek built up the Samarkand observatory in 1420, observed the luminaries, determined the exact coordinates of the stars and wrote a scientific treatise "Zij-i Sultani", which was published in 1437. "Zij-i Sultani" contains the coordinates of almost 1000 stars, which were determined with great accuracy for their time (Fazlioglu, 2008). The "Zij-i Sultani" was influential, translated into European languages and was continuously used in the universities of the world around until the XIX century.



Figure 20. The image of Ulugh Bek on 100000 so'm of the Republic of Uzbekistan (2019 y.).

The list is to be continued. More information on the representation of the image of physicists in historical-financial symbols can be found on the websites ([Redish](#), 2008; Bourjaily).

4. Recommendation

The purposeful use of the above information in physics lessons can help to strengthen the students' comprehension of the topic and increase their interest in physics. Ultimately, this will help increase the effectiveness of physical education. At the same time,

based on the information provided, it is possible to organize an optional lesson for school pupils as extracurricular activity, which will reflect the image of physicists in historical-financial symbols. Given the importance of the issue in educating the younger generation, motivate them to engage with physics, increasing their interest in physics, training them to become globally competitive professionals, and, certainly, educating them in the spirit of internationalism and patriotism, we agree that the use of the above provided information, certainly, help in improving the quality of physics classes and enhance the motivation of young people to engage with physics.

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5. Conclusion

By depicting the image of the great scientists or people and compatriots, who grew up among the nation, in state banknotes the states of the world, do not only perpetuate the memory of scientists, but also educate their citizens, including students, in the spirit of patriotism and encourage them to study science. It ultimately ensures the development of individual, the society, the country, and determines its present and future. Being proud of one's ancestors, the use of symbols, including historical-financial symbols, in the educational process solves a multifaceted and

important educational issue. Keeping in mind that upbringing is inseparable from education, the use of historical-financial symbols in physics lessons proposed in this article not only increases the effectiveness of physics lessons, but also educates students in the spirit of internationalism, patriotism and tolerance.

Acknowledgements

The authors are thankful to Associate-professor G.Kdirbaeva for reading the manuscript and helpful comments.

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