Between Femtoseconds and Otoseconds, where are the natural sciences curricula located ?

Prof. Dr. Nahed Abdel-Radi
A Professor of Curriculum and Instruction
Faculty of Education - Minia University

Abstract:

This paper deals with the concepts of (femtosecond) and its applications, which is a unit of time that represents one millionth of a billionth of a second, and is one of the most important scientific discoveries of the Egyptian scientist Ahmed Zewail, for which he won the Nobel Prize in Chemistry, as this discovery contributed to understanding the mechanics of interactions. Chemical, as it was possible to benefit from in many applications in the field of medicine, such as: treatment of eye diseases, dental fillings, and early detection of diseases, as well as in military applications. Of the prizes, it is in the field of practical application, and a unit of time equivalent to a billionth of a billionth of a second. It is also called the fastest light laser in the world. It has implications for the development of optical computers and mobile phones. The curricula of natural sciences are entrusted with dealing with the concepts of (femtosecond) and (Autosecond) and their applications in all stages of education, This is also a global trend recommended by international projects and international conferences. Accordingly, this paper recomm-e nded the need to review the standard levels document for the content of science allotted for the stages of general education, as well as the standard academic standards document for the student teachers in the scientific departments in the College of Education. Therefore, it includes these concepts and their applications, and to suggest teaching methods based on the integration between science and technology to teach these concepts. Because of its impact on the development of creative and future thinking among learners, which in turn contributes to the development of societies, and the achievement of sustainable development.

Keywords:Femtoseconds - Otoseconds - Natural Science Curricula.

Introduction:

The twenty-first century in which we live is considered the century of scientific and technological innovations, in which knowledge growth is accelerating, and technological progress is proceeding at a rapid pace. This led to an increase in scientific and technological discoveries and achievements in all different areas of life. This has placed new burdens on the curricula of the natural sciences, which became required to prepare individuals with scientific and technological culture.

Chemistry is the center of most sciences, as it integrates with biology producing a new science called (biochemistry), which is concerned with studying the chemical composition of cell parts, and integrates with physics, producing (physical chemistry), which is specialized in studying the properties of materials.

The science of measurement is of great importance in knowing the type and concentration of the constituent elements of the materials we use, as well as of monitoring and protection. When molecules enter into chemical reactions, their atoms move so quickly that they cannot be seen, but if we can photograph the process using a high-speed camera, it can re-show the reaction in motion. Slowly, this has prompted the curiosity of chemists to develop advanced methods that would study the finer details of the chemical reaction, and the results were that the Egyptian scientist Ahmed Zewail won the Nobel Prize in 1999; This is due to his research in a new field of chemistry, which is (femtochemistry).(

Femtosecond chemistry has changed the perception of chemical reactions. By using femtoseconds, we can see the

movements of atoms as we imagined them before using a special high-speed camera. Scientists around the world now use femtoseconds to study and analyze many chemicals in their various liquid forms. And solid and gaseous and their interactions with each other, and their applications accommodate many areas, starting from the study of auxiliary factors in chemical reactions to the most accurate processes related to life, as they are used in the fields of research in different biological systems.

Many researches have been conducted in the field of (femto) under the auspices of the National Science Foundation (NSF, 2013). The National Center for Biotechnology Information - a division of the National Library of Medicine in the United States of America - has conducted research in the fields of: (femtochemistry), (femtophysics), and (femtobiology) (NCBI, 2003).(

Several conferences were held for (femtoseconds) and their applications, which dealt with many aspects, including: the educational aspect related to school curricula. (femtochemistry), One of the most important recommendations is educating students in classrooms about innovations in the field of (femtoseconds).

The curricula of the natural sciences are entrusted with dealing with their content of scientific and technological innovations. To prepare a generation of scientists and innovators, for this reason Among the initiatives to improve science education was what was presented by the American Association for the Advancement of Science (AAAS), which is one of the oldest and most important scientific organizations in the world. Different weights, speeds, volumes, lengths, times and measurements.

Project (2061) Science for All Americans emphasized several principles, including: scientific culture, which is a project that dealt with twelve scientific fields, and the eleventh field dealt with general topics and concepts, such as: systems, models, change, and measurement.

The National Research Center in the United States of America (NRC) with a number of bodies and institutions, such as: the National Academy of Sciences (NAS), the National Association of Science Educators (NSTA), and the organization (Achieve) - building the Next Generation Science Standards (NGSS), which aim to link three important dimensions: scientific and engineering practices, comprehensive concepts, and main ideas. The (comprehensive concepts) dimension dealt with measurement, proportions, and quantity. These standards were developed from kindergarten to secondary school; This is in order to prepare individuals for the challenges and requirements of the twenty-first century.

Given the importance of femtosecond science, the current paper will attempt to identify the extent to which concepts related to femtoseconds are included in natural science curricula at all stages of education by answering the following questions: What is a femtosecond? What are the applications of femtoseconds in different fields? What is an auto second? What are the standards, projects and conferences that dealt with femtoseconds? To what extent are femtosecond concepts included in the content of natural science curricula at different stages? What is the method of including the concepts of femtochemistry, femtobiology, and femtophysics in the curricula of natural sciences?

What is a femtosecond?

The (femtosecond) is a new branch of science discovered by the Egyptian scientist Ahmed Zewail (1984) after many researches and experiments conducted in the research laboratories of the University of Calta, California, USA, for which he was awarded the Nobel Prize in Chemistry in 1999. femtoseconds is a million billion (quadrillion) part of a second, and the ratio between a second and a femtosecond is like the ratio between a second and 32 million years.

The femtocamera, which was invented by the scientist Ahmed Zewail, was built on a new laser technology that relies on sending short-range laser pulses and a partial beam inside a vacuum tube with a digital camera with unique specifications that can photograph the movement of molecules at their birth and before their fusion with other molecules. This makes it easy to quickly intervene and surprise chemical reactions when they occur by using laser pulses as a telescope to watch and follow the demolition and construction processes in the cell, which was the nucleus of many researches in medicine, pharmacy, agriculture, communications, electronics, and other applied and technical sciences.

Femtochemistry and Femtobiology:

The invention of (femtosecond) led to the emergence of a new science, which is(femtochemistry) and (femtosecond biology). Steps in some reactions within a time frame less than that, which are then measured in (otosecond) dimensions.

Biology can be studied using ultrashort pulsed (femto) laser technology, so biologists can look at known biological reactions over ever shorter timescales, and learn about vital processes that were not known before.

It may seem that there is a difference between (femtochemistry)and (femtobiology), but (femtochemistry) actually serves (femtobiology). So, (femtochemistry) with the interactions of biological life is equal to (femtobiology), and examples of vital processes and functions. It is now better understood because of femtotechnology: the dynamics of enzyme action, examination of DNA and protein synthesis from RNA, and elucidation of the biological processes of molecules.

Femtosecond Applications:

The benefits of the (femtosecond) appeared in the following applications:

Scientific research:

Watching chemical reactions at the femtosecond level will enable scientists to know the causes of many diseases and how to treat them, such as: the reactions that cause cancer cell divisions and how they occur, the reactions that cause aging and how to delay it to prolong human life, the reactions that cause birth defects in the fetus, and the possibility of stopping them before they happen, and knowing the genes that make people more susceptible to certain diseases.

Eye Diseases and Vision Correction:

Among the most important uses of (Femto-laser) in this field (femto-Lasik- femto-Smile) - Corneal Transplantation – Cataract Operations (femto-Cataract)..

Endodontics:

Where the laser beam is used to treat tooth decay, pull the nerve from the roots, and remove the inflamed gum tissue. Femto- rays are also used to remove the hard oral tissues, and this in turn avoids bleeding and infections resulting from drilling machines, in addition to reducing the possibility of infection due to the lack of sterilization of machines and tools.

Disease Detection:

Scientists use the (femto) technology in the early detection of serious diseases, such as: cancer and diabetes. Because through this technique, all the cells in the human body can be photographed with high accuracy, and the cause of body's infection with a particular disease can be reached by identifying cell errors. Thus, infected cells can be treated, in addition to manufacturing drugs that are more capable of treating these diseases.

Military applications:

Some governments are able to pinpoint the locations they want to target with missiles with great accuracy, without the army moving from its place, using (femtoseconds). By firing flashes of laser beams to the required locations, this beam can draw a very accurate picture in less than one second.

It is clear from the foregoing benefits that what the scientist Ahmed Zewail presented with his invention (the femtosecond) was the nucleus of many researches in the

fields of: medicine, chemistry, biology and space research, which contributed to the interpretation of many scientific phenomena. Which is beneficial to humanity.

Based on the fact that science does not compete with each other, but is an extended circle that the scientist Ahmed Zewail started with leadership in (femtochemistry), which was a revolution in the field of scientific research; It provided the opportunity to image electrons with lasers, and this is a quantum leap.It is expected that it will have the same effect for imaging the movement of molecules, and may take us to other larger and deeper regions within matter.

The Egyptian scientist Muhammad Tharwat believes that the electronic microscope, before the achievement of the scientist Ahmed Zewail, was of two types: one scans the surface of the material to be seen, and is called: (the scanning electron microscope), and another is called: (the transmission electron microscope). Its function is to try to see what is under the surface. What Zewail accomplished is imaging the movement of molecules and atoms inside the material using a laser beam at a speed (femtosecond), meaning that it does not reveal the width, length and height of an object only, but added another dimension, which is the dimension of time. Therefore, it was called the quadruple microscope, and thus scientists were able to see the object under the microscope while it was in motion. Accordingly, the interactions that occur can be monitored and studied, and what is being done now is the development of this microscope to work quickly (autoseconds).

What is an Autosecond:

Autosecond is equivalent to a billionth of a billionth of a second, and it was invented by the Egyptian scientist Muhammad Tharwat in 2016 after conducting many researches at the Max Planck Institute in Germany, and he won many awards which qualifies him to be nominated for the Nobel Prize from the scientific community, and recorded The Guinness Book of Records (autosecond) as the fastest optical laser in the world.The scientist Muhammad Tharwat mentions that the (autosecond) laser not only monitors the movement of electrons in glass, but also controls their properties to transform glass from an insulating material to a conductive material for electric current.

The progress in the applied achievement of (autosecond) on the laboratory scale adds an incentive to companies to move it from the industrial stage, as it can have a reflection on the development of optical computers and mobile phones that will exceed the speed (100) million times, and it can also have a reflection on the possibility of transmitting information using the spectral laser beam, which would increase the speed of communications between countries and the speed of communications between Earth and satellites.

The foregoing information shows the successive speed of scientific and technological discoveries and their impact on all aspects of life and individuals in society. In order to keep up with them, educational systems must be

established that can prepare generations capable of adapting to the requirements of the present and aspirations of the future.

Based on the above, many studies were conducted to deal with (femto) in science education at the university level, such as: the study of (Teo, Waikee, 2011), which dealt with measures of time and length at the level of (femto), mass, energy, basic physical quantities, and the use of atomic units in Quantitative mechanical calculations, as conducted by (Benedetta, Didattica, 2019) in an Italian university, and the (femtochemistry) unit was taught in the chemistry science curriculum. The unit included a part of (femtobiology) on the dynamics of protein formation.

At the secondary level, (Pollock, et al 2018) conducted an analytical study on spectroscopy in chemistry at the (femto) level in scientific experiments and practical training in science in secondary schools.

The National Association of Science Teachers (NSTA) emphasized the integration of scientific innovations (such as: femtoseconds) in science curricula at the middle and high school levels, where it is possible to add a course of chemical reactions equations through femtoseconds, and an expanded science course entitled "From nano to the galaxy" that deals with nano for the highest scale, including the femtosecond, and it was taught in the preparatory and secondary stages to students of the departments of chemistry, physics, biology, and earth sciences.

It is clear from the foregoing the extent of global interest in integrating femtochemistry into the curricula of the natural sciences in the various educational stages, whether in practical experiments, or in the form of courses, or units in (femtochemistry) chemistry, or in the form of measurements.

The extent to which femtometry is included in the curricula of natural sciences in Egypt:

In the light of what international studies and projects called for to improve science education to confront scientific and technological innovations, such as: (femto- and nano) science in natural science curricula at all levels of education, and with a close review of the standard levels of science content for pre-university education. This was found in the field of life sciences and the field of Chemistry at the secondary level. The reference marks and indicators did not include any reference to (femtoseconds) or (nano).

As for the standards in the field of physics, the reference marks included: (knows and understands the basics of nano and femtosecond physics and its applications).

By examining the content of the physics curriculum of the secondary stage, it was found that the physics curriculum of first year secondary school in the first unit entitled: "Physics and Physical Measurements" there was reference to (femto) as a unit of measurement only, without clarifying its nature, characteristics or applications, and there was also no reference to (autosecond), its definition, or its applications.

In addition to examining the standard academic standards document for the preparation of the student teacher at the College of Education, it was found that there are deficiencies in the indicators' handling the concept of (femto) and (oto) in natural science courses. For Physics - the student-teacher was able to understand the basics and practical applications of laser physics), while there was no reference to nano or femtoseconds in the chemistry, biology and geology courses.

Despite the global interest in including femtosecond concepts and their applications in the curricula of natural sciences at all educational levels; the results of some studies in the Arab Republic of Egypt confirmed the inadequacy of the natural sciences curricula in dealing with the concepts of (femtoseconds), and this is consistent with the results of the study by (Hani, 2020), which indicated that there is a deficiency in teaching the concepts of (femtosecond biology) among students at the College of Education. Another study by (Hassan, 2021) indicated a low understanding of the concepts of (femtochemistry) by first-year secondary students.

Therefore, it has become necessary to include the concepts of (femtoseconds) and (otoseconds) in the curricula of natural sciences at the general education and university levels, in addition to using appropriate teaching methods that are based on the integration of chemistry, physics, biology, and geology with technology (STEM); This would contribute to the development of scientific and

technological enlightenment, creative thinking and future thinking among learners, and leads to the development of societies and the achievement of sustainable development.

In light of what has been presented and in response to the results of previous studies, projects and programs, this paper recommends the following:

- The need to reconsider the content of the science curricula in the general education stages so that it includes topics for (nano), (femto and auto).
- Developing science curricula, especially chemistry and physics at the secondary level, in the light of international standards for (femtosecond) and (otosecond) science.
- Reviewing the standard academic standards document for the preparation of the student teacher at the College of Education, so that it includes topics for infinitesimal chemical and physical measurements, such as: (nano, femto, and auto).(-Holding - Holding training courses for in-service science teachers to familiarize them with femtosecond and otosecond and their applications
- Providing the educational preparation program for science teachers at the College of Education with appropriate teaching methods for teaching scientific innovations, such as: (nano, femto, and auto), which are based on integration between the different branches of science, namely: science, technology, engineering, and mathematics (STEM), or that are based on the philosophy of science standards for the next generation

(NGESS), as well as those that are based on the web, such as: network survey, and blended learning.

References

- American Association for the Advancement of Science (AAAS) (1993): Benchmarks for science literacy. New York, Oxford University Press.
- American Association for the Advancement of science,(AAAS) (1996) science for All American New York: Oxford university press, Available from : http://www.project 2061 org. Retrieved on 1 August 2014.
- Benedett.Carlotti,Didattica.Ufficale,.(2019).Unit Femtochemistry. Universita degli Studi di Perugia- IT ALLA from: https://www, unipg.it/courses/offered-programmes/course-catalogue-2019-20?idins=157278
- Department of Chemical physics (NCBI) Sundstrom(VI), (2008)
- femtobiology. Lund University, S-221 00 lund, Sweden.
- Valley Sundstrom @ Chemphys. Lu.se annul Rev phys chem. 2008;59: 53-77. From :http://www.ncbi.nlm.nih.gov/pubmed/17892434
- Gail M.Jones,Amy R.Taylor,Michael R.Falvo(2009). MESCIENCF, From NanotoGalacic. Investigations for Grades 6-12 ,Copyright.2009 National Scienc Teaching Association (NSTA). NSTA Library. from: https://common.nsta.org/ resource /?id=10.2505/PKEB237X
- Hany, Mervat Hamed (2020). The effectiveness of a proposed unit in femtosecond biology in developing achievement, divergent thinking skills, and scientific values among secondary school students, Journal of Educational and Explanatory Studies, Faculty of Education, Zagazig University, No. 108, p p (1-83).
- Hassan, Manal Ali (2021). A proposed unit in femtochemistry and its impact on the development of achievement Cognitive and Scientific Values of Secondary School Students, Educational Journal, Faculty of Education, Sohag University, March issue, part (1), 83. p p(376- 48)
- Hulbert Ehtan J (2014) when it Comes Down to it . Femtoscience is a Material Science.

- Ministry of Education (2019/2020) Chemistry for the first secondary semester, Modern Library for Printing, Egypt.
- Ministry of Education (2019/2020) Chemistry for the first secondary semester, Modern Library for Printing, Egypt.
- Monique M. Martin James T Hynes (2004) Femtochemistry and Femtobiology, Ultrafast Evenest in Molecular Science Elsevier Science: 1 Edition, Kindle Edition (April, 16, 2004).
- National Research Council (NRC). 1996. National Science Education Standards. Washington DC: National Academy Press.
- National Science teaching Associatio (NSTA) (2019). Chemical reactions: rates of chemical reactions NSTA Library from: http://common.nsta.org/search/default?action=browse&text=femto&price=&ty pe=&subject=&topic=0&gradelevel= &page=0dep= &coil=&aut hor=
- NGSS Lead states (2013).Next Generation Science Standards: For States by States. Washington, DC: The National Academies PRESS.
- NGSS@NSTA:STEM STARTS HERE.(2012). Three Dimensions of the Next Generation Science Standards (NGSS). Retrieved from: https://www.nextgenscience.org/resources/ngss-appendices.
- Qabeel, Tariq. (2016). The Scientific Curiosity Behind Zewail's Achievements, available from: http://www.scientificamerican. com/arabic/blogs/sciencebservations/ scientific-curiosity-behind-zewail-achievements.
- Swango C .Jill &Sally Boles (2003). Tests and Form. National Science Teaching Association (NSTA) from : https:// common.nsta.org /resource/?id=10.2505/9780873552257.AppA
- Teo,BoonK.,Li,Wai-Kee(2016).The Scales of Time Length,Mass, Energy, and Other Fundamental Physical Quantitiesin the Atomic World and the Use of Atomic Units in Quantities Mechanical Calculation .Journal of Chemical Education,V.88,N.7,P.921-928Jul,2011.
- The National Authority for Education Quality Assurance and Accreditation (2016). Document Standard Levels of Science Content for Pre-University Education, Egypt.
- The National Science Foundation(NSF)(2013). NETS:Medium Collaborative Research: Information Architectures for Femto

Aided Cellular Networks .Cornell University from: .https://www.nsf.gov/awardsearchAward?AWA_ID=1430493

- Zewail AH. (2000) femtochemistry: past, present and future. Pure Appl. Chem. 72(12):2219-2231, 2000.
- Zewail Ahmed H. (1999). Femtochemistry: Atomic-scale dynamics of the chemical bond. Copyright © 2000 American chemical society the journal of physical chemistry A, 247-367.
- Zewail Ahmed H. (1999). The birth of molecules scientific American, December 1990: 40-46.

***