

THE CREATION OF INFORMATION WEBSITE "FULLERENES" AS AN EDUCATIONAL TOOL

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Abstract

Fullerenes are the basis for the rapidly developing science of nanotechnology. Nanotechnology is included in the list of priorities approved by Lithuanian Ministry of Education. Fullerenes and their usage, as a new field of science, are not included in either the general or high education curriculum. Following the analysis of e-sourcing, it became clear that there is no Lithuanian electronic source of information, in which there is more than one paragraph describing of fullerenes history, theory, usability and so on. Found information is incomplete, often inaccurate, and completely scattered. In order to determine Internet users' knowledge about fullerenes, a short questionnaire survey in different education and age groups were conducted. The results of the survey suggest that currently the majority of respondents (more than half of those with university education) do not have a basic knowledge of fullerenes. Created an electronic information tool for teaching Fullerenes is presented. It analyzed and structured educational material about the history of the discovery of fullerenes, scientists who discovered them, the theory of fullerenes, their applications, examples, illustrations, points of interest, simulation. Developing the site relationship with the Nobel Prize laureates who discovered fullerenes Professor Robert F. Curl and Professor Harold W. Kroto has been established. Developed electronic information teaching tool "Fullerenes" (<http://www.fulerenai.eu/>) can be used as a cognitive tool for educational institutions.

Key words: fullerenes, information teaching tool, nanotechnology, questionnaire, website.

Introduction

One of the main goals of modern information society is a digital literacy. This is considered as a key skill of twenty-first century. There is no doubt that today's information and communication technology (ICT) can be enormous. Problematic areas - technology "transfer" in the educational system. ICT automatically is not valuable in the educational process. Using them it is necessary to develop educational methods so that ICT would become a direct participant in the educational process. Integrating ICT into the educational process has a dual purpose: to effectively implement educational challenges, to respond to the public and ongoing training needs and to develop ICT competence (IKT taikymo ugdymo procese galimybės, 2005 / The opportunities of ICT using in education, 2005). Gradually, more and more modern information and communication technology influences teaching and learning of different subjects and the whole educational process. Computers and computer technology in schools is increasing, they appears not only in information technology classes, but also in other subjects. Various investigations are conducted in Lithuania. Based on National student achievement testing (2004) can be stated that many students spend a lot of time at the computer. The followed research on the positions of the first-year undergraduates has disclosed that practically, they have almost unlimited possibilities of using a computer and the Internet. The most required types of information and communication technologies for the surveyed first-year undergraduates are a computer used for general study and the Internet - to search for

information. (Lamanauskas, Šlekienė, Ragulienė, 2010). This opens up many opportunities to change the process of education.

Recently, common interest in using computer-based technologies for the purpose of teaching/learning sciences has significantly increased at international level. New technologies (in particular, the internet) provide teachers with many interesting tools that can be used to improve the teaching–learning process. The usefulness of these tools makes important for teachers to have more information about the advantages and possibilities of using technology in the classroom (Kaminski, 2005), as well as about the results derived from their application. Physics is one of the first areas where the possibilities that computers may offer for the employment of new teaching methods have been and are still explored. The usage of computers in Physics instruction began in the seventies (Chonacky, 2006). Since then, there have been many studies that analyze the effectiveness of new technologies applied to teach Physics (for an extensive revision of these results, see for instance (Kenny, Bullen, & Loftus, 2006). There is a wide debate about the influence on computer-assisted education in Physics courses (Kenny et al., 2006). Some authors consider that computational Physics provides a broader and more flexible education than a traditional Physics course. Moreover, they consider that teaching Physics as a scientific problem-solving paradigm is a more effective and efficient than using the traditional approach (Landau, 2006). A variety of computer applications have been developed and used in teaching Physics, such as spreadsheets, multimedia, simulations, websites, computer-based laboratories and etc (Bernhard, Lindwall, Engkvist, Zhu, Degerman, 2007; Finkelstein, Adams, Keller, Kohl, Perkins, Podolefsky, Reid, LeMaster, 2005; Pol, Harskamp, 2005; Wieman, Perkins, 2005).

The amount of information is growing daily; it is easier to find wanted information. The emergence and popularity of the Internet has accelerated the dissemination of information hundreds of times. A growing electronic library, encyclopedias, teaching aids allow students, teachers, professors to learn and improve faster and efficiently. When we discover a topic that interests us, we can not only read the theory, but at the same time view photos, visual material, even examine three-dimensional object models, virtually attend lectures of scientists from the whole world. If we have any questions, we can always seek help from the scientific community active on the Internet, where we can post discussion forums or chat rooms, searching for a solution. However, it is noted that there is a lack of electronic information, computer training means in Lithuanian. This is especially emphasized in the scientific community. English is the most commonly used language in science. This language released most scientific journals, books, going on the most important scientific conferences (David Gradol, 2000). There are no problems to find the desired information or the latest knowledge in English, because in this language the latest scientific research, discoveries and other materials on the Internet appear fastest. Some information can be found in our native Lithuanian language. Unfortunately, if relatively new scientific information written in the Lithuanian language is looking for, it is probable that will not find anything, information will be out of date, or will find only abstract. English software consumption in schools does not allow for equal education in the state language. Great significant amount of information in English and other languages overshadows native language. It's best for students mastering the subject matter that the computer programs are written in their native language (Babravičius, 2002).

The Problem and Relevance

15 years ago, the term “Fullerenes” appeared in the scientific environment. Internet search for fullerenes in the English language received hundreds of results, and in Lithuanian language appeared just 4-5 results where this term was mentioned and described in one to two sentences. How situation has changed now? Sources of information in English

have increased thousands of times, and in Lithuanian appeared several dozen of sources, with only mentions of the fullerenes. Because of this information gap, as shown by a conducted survey, there are very few of the Lithuanian people, who are aware of the fullerenes and their importance for science.

Nanotechnology is an interdisciplinary and one of the fastest growing fields of science. This science and advancing technology opens up new possibilities for developing new materials and devices; no one of which previously could not even be imagined. Unfortunately, very few people know that the discovery of fullerenes in 1985 gave rise to nanotechnology, not only opened up this new field of science, but also strongly affected the physics, chemistry and many other scientific fields (ACS to Honor Discovery of Fullerenes. Azo Nanotechnology, <http://www.azonano.com/news.asp?newsID=19,861>).

This discovery had a very great importance in physics, chemistry, computer science and other fields of science.

Fullerenes and their application, as a new field of science, are not included in either the general or high education curriculum. Following the analysis of e-sourcing, it became clear that there is no Lithuanian electronic source of information, which should be more than one paragraph description of fullerenes history, theory, usability and so on; found information is incomplete, often incorrect, and completely scattered. The lack of such information and educational material on fullerenes, whose discovery was so important that in 1996 was awarded the Nobel Prize, was a reason to fill this information gap by developing educational information web site.

Research Focus

The object of this study is information about the fullerenes and the design principles of educational information website. The main goal - the creation of the Lithuanian electronic information freely available teaching means "Fullerenes" for physics and chemistry teachers, students, pupils and others interested in education innovation.

Methodology of research

General Background

In order to at least partially eliminate the lack of information about the fullerenes in Lithuanian language, the task for students of Šiauliai University, Faculty of Natural Science was formulated - to create an electronic learning tool for fullerenes. Student in physics and computer science Rimvydas Velykis has taken to perform this task. The aim was to provide information about the fullerenes attractive and accessible to readers of all ages and backgrounds. Mastering of this subject and the creation of a website on fullerenes became a student coursework, and then the bachelor's work.

Procedure

- In order to determine Internet users' knowledge about fullerenes, a short questionnaire survey in different education and age groups were conducted (<http://www.fulerenai.eu/apklausa/>). The questionnaire consisted of five questions; four of them were closed type. Free Lithuanian system of questionnaires and surveys on the Internet "Apklausa.lt" was used. The questionnaire was distributed online through various channels (forums, email, social networks). Students of Physics and Informatics specialty have been questioned, too. The survey involved 224 respondents. Most participants were 19-24 (110/49%) and 25

-35 (76/34%) years old. Only a small part of respondents were 13-18 (16 / 7%) years old pupils and older than 35 (22/10%) years adults. More than half of survey respondents have a university education (122/54%), almost one third - incomplete university (60/27%) and the remaining part - secondary or basic education.

- In the next stage of study analysis of existing educational online resources on fullerenes have been carried out, training materials were translated, analyzed and systematized.
- In the third stage of study the electronic learning tool for fullerenes, and access to it was created. This required knowledge of programming, data management, and work with Web servers and content management systems. One of the most popular and advanced content management systems (CMS) Wordpress was chosen in order to carry out the work. Wordpress CMS is a free open-source platform that is widely used around the world. More than 27 million users around the world have used this system in 2010 September data (The Power of Wordpress. **Techking**, <http://www.testking.com/techking/infographics/the-power-of-wordpress-infographic/>).

A wide range as well as free and mostly open source software for site content creation and editing has been used: Notepad ++ - program is designed for both simple text editor, and for writing of a number programming languages; FreeCommander – for file transfer from PC to the server; Google’s Chrome – a modern, fast web browser that supports all required standards. It has been used for testing the site and filling in the content; PoEdit - for Wordpress system translation into the Lithuanian language; Gimp – for photo editing; OpenOffice – for word and tables processing, Virtual Dub – for video conversion and editing; Subtitle Workshop – for Subtitle creation and connection with video file.

Research Results

Upon evidence lack of information about the fullerenes in Lithuanian language, the survey results are not surprising. Even 83% (185) of respondents have never heard of fullerenes and have no idea what it is. One-tenth of respondents (23) has heard the term, but could not say what it is. Another 3% (7) of the respondents have heard and know something about them. Only 4% (9) of the surveyed people know about fullerenes, and could describe them (Figure 1).

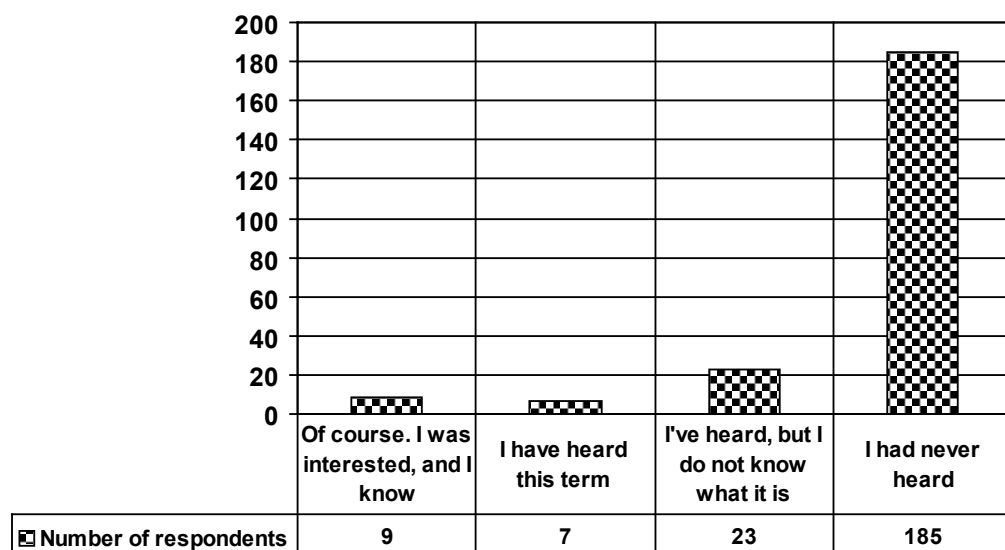


Figure 1. Respondents' knowledge about fullerenes.

Responses to another question confirmed the fact that scientific news in the English language occurs faster, while in Lithuanian sources this information is lacking for a long time. The discovery of fullerenes gradually led scientists to the discovery of graphene, which since 2008 has been approved as the strongest known material in the world (Engineers Prove Graphene is the Strongest Material. PhysOrg.com project. [Http://www.physorg.com/news135959004.html](http://www.physorg.com/news135959004.html)). Unfortunately, only 12% (28) of respondents know this fact, while 79% (176) still think that the strongest material is still considered to be a diamond. 6% (14) believe that the strongest material is steel, another 3% (6) – graphite (Figure 2).

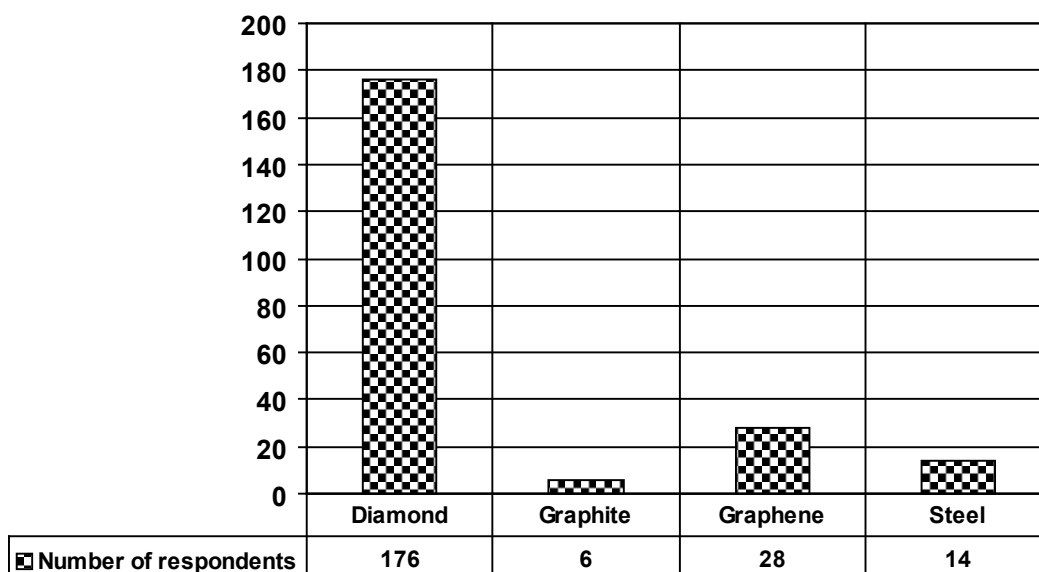


Figure 2. Respondents' knowledge about the strongest material.

Only two respondents answered to open type question which was asked to briefly write what you know about fullerenes and where you learned about them. Their answers were short and abstract: *"I studied physics: fullerenes are mentioned in the physics of materials and nanotechnology"*; *"Ball shaped carbon compound with a special, completely unexplored properties"*.

Reviewing the survey results can be assumed that the creation of an electronic information educational tool "Fullerenes" should be useful, because currently the majority of people questioned (more than half of those with higher education) does not have any knowledge of this important material. The results are recorded, but a survey carried out further. It is integrated into an educational tool and using it for the first time, visitors are requested to complete a questionnaire. It aims to collect more data.

Structure and Analysis of Information Educational Tool "Fullerenes"

Creating an educational tool as a web-site have been taken into account their requirements and guidelines. It was followed accepted web standards and "School website" guidelines developed by the School Improvement Programme Coordination Unit at the Ministry of Education (*Mokyklų interneto svetainės. Mokyklų tobulinimo programa*. <http://www.mtp.smm.lt/metodines.htm>). Site visitors enter the address "www.fulerenai.info" in your browser address bar and enter the site *Fullerenes* home page (Figure 3).

It contains a brief description of the site and welcome of one of the fullerenes' discoverer Nobel Prize laureate Robert F. Curl.

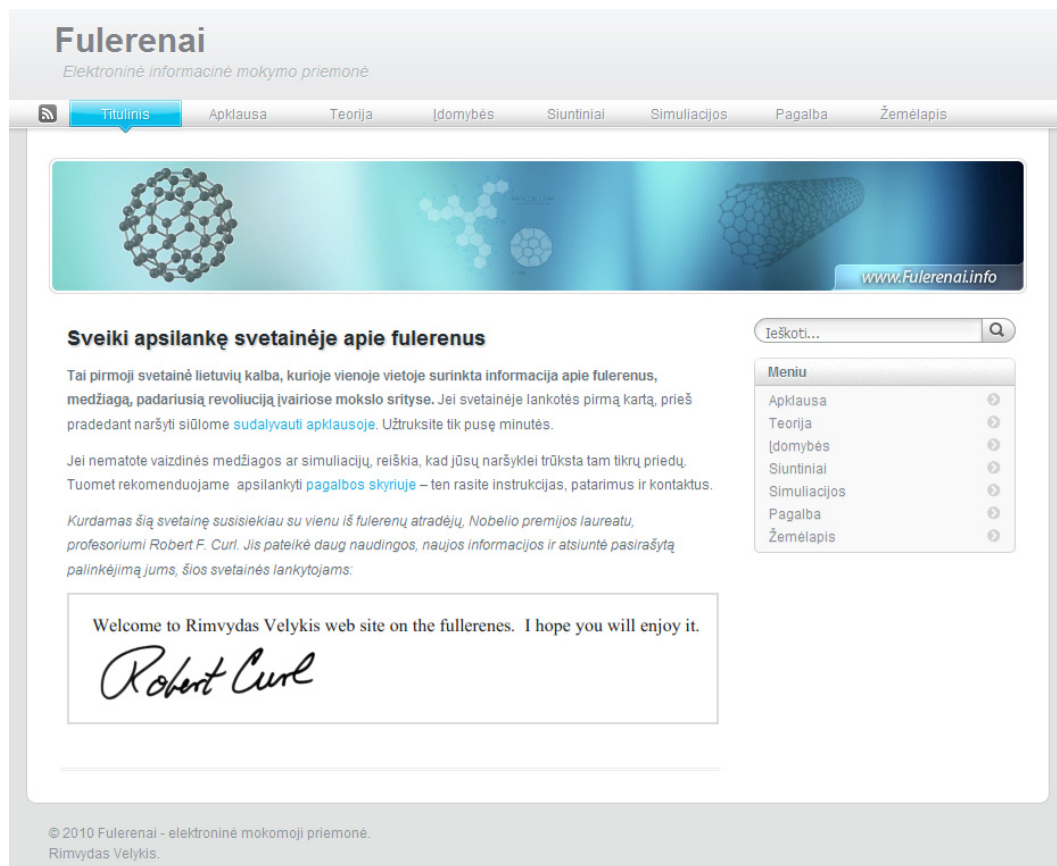


Figure 3. Web site *Fullerenes* home page.

The main site menu is always visible at the top and it consists of eight chapters. Some of them split up to three internal levels. When you move the mouse cursor on each of the main section is added to the menu appears with the first-level internal pages. For browsing convenience, an additional menu at the bottom of each page is displayed. It shows the entire path from the home page to that which is now under review.

By clicking the button *Survey* on the Main Website menu, you can take part in the survey mentioned above. It is proposed to complete a questionnaire, if the new visitor visits the site.

On the page *Theory* a list of internal pages of the theory section, with active links is presented: *How Fullerenes were discovered* – the history of the discovery of fullerenes is posted; *Discoverers* – chapter designated for scientists who discovered fullerenes (Harold W. Kroto, Robert F. Curl, Richard E. Smalley); *Nobel Prize* – page describes when, who and for what received the award; *Second Nobel Prize* - a description of another major award, which is associated with Fullerenes is presented. It describes the graphene, its discovery and the possibility of its use; *Significance of the Discovery* – page explains what are the benefits of the discovery of fullerenes to science and humanity, what new possibilities it opened up; *What are the Fullerenes* – theory, definition, examples and illustrations are presented; *Applications* – describes what are the applications of fullerenes now and what are the possibilities of application in the future; *The Origin of the Term* – page explains where and why came such name of newly discovered substance; *Types of Fullerenes* – a description of the existing types of fullerenes is presented.

On the page *Interesting* a list of internal pages of topics are presented: *Other Facts* – brief comments, interesting facts about the fullerenes are collected; *Visual material* – C_{60} simulation is given (video clip showing how to simulate three-dimensional computer model of C_{60} molecule of fullerene), *Documentary* (complete and informative documentary film about the discovery of fullerenes), *Google and C_{60}* (the video, which recorded how largest search company logo has been changed noting the 25th anniversary of the discovery of fullerenes); *Manufacturing fullerenes* – provides instructions on how to make a paper model of fullerene, there is necessary templates for downloading and printing; *Fullerenes price* – the former and the current price of fullerenes production, sales, and their comparison are described; *Fullerenes in space* – a description of the recently recorded the fact that the fullerenes were discovered in cosmic space is presented; *Geoset* – information about educational network (GEOSSET), founded by one of the discoverers of the fullerenes H. Kroto, is presented.

Downloads page describes the programs Ninithi and Nanotube Modeler, which can simulate three-dimensional models of fullerenes, explains how to use them; download links are added.

On the page *Simulation* various simulation C_{60} and other types of fullerenes are presented.

By clicking the button *Instructions* on the Main Website menu, necessary browser add-ons and links where you can download them. Here are some guidelines to what browser is best and how the navigation works.

On the page *Site Map* a clear structure with active site-wide links are automatically generated and communicated.

Lithuanian subtitles for the most of presented video clips are created (Fig. 4).

Wolfgang Krätschmer pasakoja apie fulerenus ir savo atradimą (liet. k. titrai):



Figure 4. Videos made with Lithuanian subtitles.

At the time of developed this information educational site, business relationship with one of the fullerenes' discoverer Nobel Prize laureate Professor Robert F. Curl was established. Much valuable information, his personal work relating to fullerenes has been received. Prof. R. Curl has sent a signed greeting for website visitors, which is placed on the title page (Figure 3).

The work included contacts with the other fullerenes' discoverer prof. Harold W. Kroto. The Nobel Prize laureate provided a number of useful links to sources of information, good advice on the development of the site and selecting the proper material. Harold W. Kroto recorded a short virtual lecture about Lithuania and the importance of this educational electronic information tools. There H. Kroto talks about "Geoset" network in Lithuania, thanks for access to this educational network. Lecture GEOSET in Lithuania (Figure 5) is made available to GEOSET (Global Educational Outreach for Science, Engineering and Technology) network website - www.geoset.fsu.edu (a copy is provided in this website www.fulerenai.info/geoset/).



Figure 5. Harold W. Kroto virtual lecture on Lithuania's accession to the "Geoset".

Conclusions

- Fullerenes are the basis for the rapidly developing science of nanotechnology. Nanotechnology is included in the list of priorities approved by Lithuanian Ministry of Education. Overview of information sources show that there is no electronic source of information, in which is more than one paragraph description of fullerenes history, theory, usability and so on. Found information is incomplete, often inaccurate, and completely scattered.
- It can be said that at present the majority of people surveyed (more than half of them with university education) does not have a basic knowledge of fullerenes.
- Educational material has been analyzed and structured in created electronic information website "Fullerenes". It comprises the history of fullerenes discovery, the chapter about discoverers scientists, theory of fullerenes, their applications, examples, illustrations, points of interest, simulations.

- Developing the site has been established relationship with the Nobel Prize laureates who discovered fullerenes Professor Robert F. Curl and Professor Harold W. Kroto.
- Developed an electronic information tool for educational "Fullerenes" (www.fulerenai.info) should at least partly fill the gap in informational and educational material on this subject. This electronic tool can be used as a cognitive tool for educational institutions. It would be useful to physics and chemistry teachers, as well as students, pupils and everyone interested in education innovation.

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