

EXPLOITING THE INTERNET RESOURCES IN PHYSICS EDUCATION

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Abstract

The significance of the world wide web - Internet permanently increasing. The first computer network was prepared by physicists working in European Nuclear Research Centre - CERN. This article concerning possibilities using of the contemporary Internet sources at all stages of the physical education. These possibilities are selected in twenty three points and shortly discussed in main part of this article. In ending of this paper the merits and dem

Introduction

The Internet - a global system of interconnected computer networks - is by far one of the most revolutionary tools of our time and virtually has become a part of everyday life. It is also a tool that has revolutionized the process of teaching and learning like nothing before. It has transformed every room with a computer and an Internet connection into the vastest library and classroom one could ever imagine.

It is also an evident fact that in the new millennium, the World Wide Web - a system of interlinked hypertext documents accessed via the Internet - is an ingenious invention. It dates back to 1989 when physicists while working at European Nuclear Research Center - CERN, found the solution to the problem of merging the technologies of personal computers and computer networking into a powerful and easy to use global information system.

According to a recent own study, there have been more than 980 billion documents on the Web, including 270 million in Polish. (Results from march of 2009 year). By far the most Web content is in English. It is clear that the breathtaking growth of the Web is leading to information overload. Finding what you want is not easy, and becoming proficient at selecting sources requires relevant experience. Effective instruction is necessary to assist students in navigating the Internet.

In its widest sense, physics education refers to both the methods currently used to teach physics and to an area of pedagogical research that seeks to improve those methods at any level of education, middle and secondary grammar schools, colleges (baccalaureate programme) and universities with physics as an area of study as well as post-graduate studies and those leading to doctoral degree.

Moreover, physics education includes additional training for physics teachers as well as popularizing and disseminating knowledge of physics to a broad public - young people and adults. The target participants in physics education are schoolchildren, college and university students, schoolteachers, academic teachers, research workers, and adults within the general public.

Physics education online

Historically, physics has been taught at the secondary school and university level primarily by the lecture method, together with laboratory exercises aimed at verifying concepts taught in the lectures. Let us try to examine, in a systematized way, the new possibilities of exploiting the Internet resources in physics education.

1 Factual information

Internet resources can be made good use of alongside existing classic information resources such as textbooks, lecture notes, scholarly journals, scientific books for the general public, slides, CD-ROMs, films, and the mass media. A good example of websites containing physics-related factual information including news of achievements in physics are numerous sites linking to the Virtual Universe and Wikipedia [1-3]. Information on the websites can take many forms, including that of a crib [4].

2 Information about major events in physics

The Internet with its potentially unlimited resources opens a new world to teachers and other information seekers, and makes formerly out-of-reach information accessible. On websites there are texts about significant events in physics such as discoveries of new phenomena or objects and nominations to the Nobel Prize - widely regarded as a highly prestigious award, not only among physics [5]. Worth noting are the pages containing information of the most recent accomplishments in physics, still in a draft form waiting to be edited and published [6].

3 Physics quizzes, tests, and exams online

Successful attempts to utilize computers or so called electronic digital machines to assess students' performance and achievements had already been made in the early 1960s. Modern computers have by far outclassed their ancestors in terms of technical and performance parameters. Scientifically objective physics tests on instructional websites, generally constructed by schoolteachers and academics [7,

8] constitute an excellent technique of instant evaluation of testees' performance. A major plus point is that you get evaluated instantly. Sets of solved and unsolved physics problems designed for a wide range of students are ideal for physics test preparation. Reviewing and mastering these problems in physics help you enhance your problem solving skills, provide instant feedback on your progress, and prepare for college or university tests or exams.

4 Collections of physics problems

Physics problems constitute a crucial element in physics education. Hence, sets of problems that cover the key areas of physics are often published in a book form. Websites are a fit place for a variety of physics problems. These are both the problems selected from the collections of problems in a book form and the problems made ready to be posted on the Internet. The problems are put by teachers of physics and academic teachers and are aimed at school and university students [9]. A more detailed analysis shows yet another phenomenon of pupils and students requesting the solutions to the problems and/or encouraging the authors to give detailed guidance on solving relevant problems [10]. Physics problems can also be found on various discussion forums that are held on the Internet.

5 Olympiads and physics competitions

While surfing resources on the Web, looking for information on Physics Olympiads and physics contests it becomes evident that, as in the case of physics problems, they fall into two separate categories. One category comprises sites containing information on organization and entrance requirements the participants have to meet as well as the sets of tasks and problems. The creators of the sites are the institutions in charge of preparations for and staging Physics Olympiad or competition [11]. The leader among these is the Organizing Committee of the Polish Physics Olympiad, Regional Committees, and the Queen Jadwiga Fund of the Jagiellonian University which organizes competitions entitled 'wietlik' [Skylight] [12]. The other more numerous list of sites contains views and opinions, commentaries, and occasionally the solutions to the Olympiad problems [13, 14]. There is a wide diversity of creators of these sites though schools and private persons seem to prevail.

6 Physics lessons scenarios for teachers

There is a wealth of useful material for teachers making preparations for their physics classes. These are, among other things, detailed descriptions of the procedures for the execution of the content of the course, with a focus on key uncertainties, as well as the formulations of lesson topics and syllabuses. Noteworthy are physics lessons scenarios [15] - outlines of the lessons giving particulars to detailed plans and possibilities. Such scenarios can be found on the sites that are administered mainly by schools or private individuals

7 The descriptions of physics experiments as an extension of teaching materials

Experiment plays many roles in science, one of which is to test theories and to provide the basis for increasing cognizance of reality. Experiments online may have different levels of difficulty and the possibilities of performing them vary considerably in costs and sophistication - with experiments that require professional and costly apparatus and those which can be conducted with the use of some household items [16, 17]. For school students of importance is the former type of experiment which is likely to involve them and encourage them in performing on their own. Apart from the descriptions of on-line experiments we can also find users' inquiries and requests for help with their homework [18].

8 Visualizations and demonstrations for physics teachers

Polish Internet resources concerning computational visualizations in physics are rather modest. Individual experiments with visualized demonstrations predominate on home pages administered by schools and private individuals. A fairly large number of pages is on the successive editions of the All-Poland Competition for the Demonstration of Visualization in Physics held by the Cracow Division of the Polish Physics Association in close collaboration with the Department of Physics and Applied Informatics at the School of Mining and Metallurgy, and the Institute of Physics, Jagiellonian University [19].

The resources in English, and particularly American English, which have been created by under the patronage of the PIRA - Physical Instructional Resource Association, are quite substantial. A number of American colleges and universities have participated in the project, including the University of Minnesota [21]. There are numerous links to similar websites, for example, to recommended textbooks, which increases their usefulness [22].

9 Information on professional advancement for teachers

The Internet is a major source of information in most areas of life in any social activity. This also concerns professional advancement of physics teachers. Advancement requires the teacher to meet defined criteria related to teaching practice and professional development. Information on such matters as well as that concerning the requirements to be fulfilled can be found, generally, on the home pages of educational institutions that administer them. [23]. In addition to that there is a lot of professional counseling and legal advice with commentaries on relevant regulations and legal articles [24]. These are helpful to those who aspire to take the next step along their career path. There are also job offers for teachers and the addresses and telephones of educational institutions, and the users' opinions about professional advancement.

10 Virtual reality simulations in the physics education

The recent development of a computer-based virtual reality simulation programme is a solution for realistic hands-on experimentation. Physical phenomena that are neither easy to perceive nor to measure in usual experiments can be presented in a virtual world and viewed in many different perspectives. Among some good examples of dangerous, high cost, and complicated experiments that have been realized in a VR system that are available on the Internet are: Brownian movement, Compton effect, and nuclear reaction. The system allows the user to display, move around, and interact with virtual worlds. He can change the viewpoint to see the elements of the

machinery, switch the direction or the intensity of the magnetic field, adjust the frequency of revolutions, etc, and influence the course of a virtual reality experiment. The creators of the sites with simulation experiments are students, teachers, research workers, and other information technology enthusiasts [26]. Apart from simulations, some pages contain commentaries and descriptions of physical phenomena.

11 Catalogues of teaching aids for teachers

The latest version of online catalogue designed to provide physics resources features thousands of items offered by renowned companies, such as Leybold or Phywe Systems - the largest manufacturer of educational scientific apparatus. Printed versions of catalogues are really voluminous and heavy, which means high distribution costs for relevant firms. Therefore, the manufacturers of educational teaching aids are looking for new and more effective means of informing potential clients. One such way is the Internet [27] - a source of a number of resources. It is a place where a full list of offers by a number of renowned manufacturers can be found. They also provide instructions for selected products and articles on the history of their first appearance as well as other topical issues [28, 29]

12 Physics popularization in academia

Today, most physics departments throughout the world have their own home pages available on the web site with information on an organizational structure, faculty, selected publications, course offerings, research trends, etc, as well as resource links and information about the various support networks [30, 31]. A substantial number of institutions promote physics with a range of activities, such as delivering public lectures on to a general audience, arranging workshops for students and teachers, and discussion panels. Information on such events can be found on the relevant department's home pages.

13 Virtual reality field trips

Some research departments dealing with physics offer virtual reality trips on the Internet to those who wish to visit their laboratories.

Such trips are possible thanks to certain Web pages which provide information about research trends developed by the relevant department, appropriate route maps as well as numerous photos featuring apparatus along the route. A good example of the research departments which offer virtual trips are the laboratories dealing with ultra-strong magnetic field in Lolland and the US as well as the CERN - the European Organization for Nuclear Research [32, 33]. Without doubt, Web-based virtual reality field trips provide a more diverse and effective learning experience to students who may never have the opportunity to see such things in person.

14 Descriptions of physics laboratory apparatus and equipment

On the web pages we can find descriptions of equipment and apparatus used for physics experiments. They may vary in their dimensions and applications. Noteworthy is, for example, an extremely sensitive electronic electroscopes, which consists of an electro-luminescent diode, an unipolar transistor, a resistor, an 9V battery [34]. A special mention deserve: a Marx generator, Tesla coil, high-voltage power supply, and a natural phenomenon called Jacob's ladder [35]. These web pages are addressed both to young people and teachers. The descriptions of pieces of equipment, often very detailed, contain accounts of the problems encountered by their constructors. Apart from this, we can view discussion forums for those who have built a particular piece of equipment and who share their experience and problems that occurred during construction and operation..

15 Online physics lectures for school students and university students

In the Internet age, we potentially can use the power of the classroom teaching plus the Internet to produce a new type of global education, an open source model of training. Many academic teachers and researches across the world are putting their lectures on the Internet, either on a special website, such as school, community, blog sites or on an information site of the educational institution where the author is employed [36,37]. Lectures vary in quality and exactitude,

starting from very exact, carefully elaborated disquisitions in the form of textbooks, to a set of handouts containing a list of issues to be discussed. Such lectures are mainly intended for university students but they may be easy enough to comprehend and follow for middle and secondary school students, and for use with homework and self-study assignments.

16 Physics education software

Both in the education of physics and in physics research there are endless possibilities for exploiting software, mainly for simulation and calculating. Furthermore, the Internet offers a vast number of web sites that provide varied educational software for use in physics teaching and research work [38]. The websites are controlled, operated and administered by research and academic institutions, schools and private persons [39]. They often offer free access downloads.

17 Paradoxes and curiosities

The paradoxes and curiosities of physics seem to be attractive element in the physics content area. Therefore, web authors readily create accessible web pages in the hope of enhancing users' interest in them [40]. The same can be said of the use of paradoxes, optic/visual illusions and brain-twisters. In most cases such physical curiosities pages are administered by schools or individual persons [41, 42]. Regretfully, the authors of these web pages do not use paradoxes and curiosities to their full didactic potential as they fail to provide adequate explanations.

18 Students' participation in online discussion forums

Participation in an online discussion group allows the user to actively engage in online communication with other participants. He is both a recipient and a creator/author of information. Forums or newsgroups are popular among many users who readily visit discussing places and give their opinion on the Internet. Unfortunately, the lack of censorship does not bring about the lack of self-censorship,

limited vocabulary, poor enunciation and offensive language are often a reflection of an author's mind. Discussion topics may vary according to intended objectives, for example, a physics problem or an event in physics, such as an important discovery or a reception of the award for scholarly achievements. In some cases the participants' statements is a clear evidence of not only their low intellectual standards but also linguistic ineptitude reflected in limited vocabulary, grammatical and spelling mistakes. Another issue involves the problem of verification, preservation, updating, and revising the statements. On some sites we can view statements which are two or more years old, on some of the others they have been deleted after few weeks.

19 User generated content complement in the printed media online

User generated content on the web is a phenomenon which has occurred only recently. Internet users generate their own content and distribute it on a variety of websites. Obviously traditional printed media are facing a new competitor in the media market: the user. Some books with complemented content are available on the Internet. Most of scholarly journals online, however, date back to a few years ago. The more recent ones have only a table of contents and some selected article. This is due to a rather laborous process of digitization of the older materials. Newer materials have generally been converted into a digital form. For example, *Postpy Fizyki [Advancements in Physics]* is available in both online version and printed version [45]. Some other periodicals post mainly general information which is informative in nature, for example, about the subject matter [46]. As for the online books, they may have chapters complemented with extended information and software for simulating some physical phenomena, such as diffusion and body melting.

20 Physics biographies

A computer with adequate software is an excellent tool for sorting out and searching according to the assigned criteria from among a vast array of elements. It is these types of operations that are performed while creating databases and biographies. That is why online

physics bibliographies prove so useful. Bibliographies of this type are created by information departments of scientific libraries, specially appointed for the purpose as well as by schools and individual persons [47]. In the nature of things, biographies compiled by the former group of above mentioned institutions are more extensive and professional in character. Biographies created by the latter group may come in useful as a physics teaching aid in a given type of school [48].

21 Organizational information for the members of physics associations

Physics associations of different countries, such as the Polish Physical Society or the American Physical Society have their web pages with information on organization structure, the board, membership, membership fees, policy, publications, programmes, etc. As a general rule, physics societies' homepages are carefully prepared with contact information, and equipped with numerous links to www pages that are devoted to physics journals and physicists.

22 Video-films featuring experiments in physics

By way of the Internet we can gain access to short video-films that feature physical experiments [51, 52]. Longer films may require more memory and obviously much higher transmission speed. Therefore only short films are accessible on the Internet which last only no more than dozens of seconds to a few minutes. Such films show the most critical moments in the process of the relevant phenomenon. One of the advantages of such films is that they a show can be repeated several times, which allows users to observe the interesting moments in the experiment more closely.

23 Scholarly articles in the area of physics

Scholarly communication is undergoing transformation due to the rising costs of print and paper. The increase in subscription fees also presents a serious threat to library purchasing capability. A solution to the problem is the necessity of designing more effective electronic publishing systems, creating digital libraries, and more subscribing to

online content. There are numerous databases which store numerous texts on the relevant from different science disciplines, for example mathematics and natural science [53, 54]. Subscribing to journals online may mean lower costs and easier and faster accessibility to a complete set of articles or other content by means of hypertext and search engines.

The merits and demerits of the Internet

Taking everything into consideration, it is evident that the electronic resources can successfully supplement the educational process at all levels of physical education by all its participants: school and university students, schoolteachers, academic teachers and researchers and other physics enthusiasts.

Making use of the Internet has its outstanding merits, for example, easy and ready access to a wealth resources and any kind of attractive, diverse, and up-to-date information on any topic under the sun. Accessing the content on the relevant pages is fairly simple, since the user only needs to know how to handle a search engine. And the whole process takes no more than just a few tenths of a second.

Another good point about using the Internet is that, except for broad band Internet fees users pay, the Internet is free of charge and most Web access is anonymous. Only few pages require authentication and seven fewer require the user to pay a fee to access.

Yet another aspect of the Internet that is appealing to users is that graphic design and layout ensure that content is presented in an attractive style and easy to read or view. Important pages have hyperlinks to them whose function is to direct a Web browser to the address they link to. Apart from text and images, sound can be used as a carrier of information. Some pages offer access to animation and videofilms. All this makes up a hypertext that is displayed on a computer, with references, or links to other text that the user can immediately follow.

An important aspect of the Internet is that it enables the user customization. Thanks to the hypertext the user may, for example, choose conditions for displaying data, the size of the font, a display format, etc. All those who are searching for the relevant information for the assignments: learners beginning their physics course as well as students and professors may make a good use of the Internet.

As all man made systems and devices the Internet is not foolproof either and has it obvious drawbacks. One of which is the issue of the quality of information which is offered on web sites. Since anyone can post their texts on the Internet and to a large extent they are uncensored. Unfortunately the currently available search engines fail to check the validity of information. Although many sites offer high quality information there are reports of inaccurate and misleading facts on the Internet. As a result some young physics learners may have problems with assessing the validity of the relevant texts.

Yet another drawback is the fleeting/transient aspect of online information resulting from the accidental disturbances in accessibility to the Net. Each of the web pages can be disconnected at any time by the administrator. Taking this into consideration, users should remember of saving the relevant data as they may disappear for ever. To sum up, it is evident that the merits of the use of the Internet in physics education outweigh the dismerits, and against which we can protect ourselves.

References

- [1] <http://www.wiw.pl/fizyka/>
- [2] <http://pl.wikipedia.org/wiki/Fizyka>
- [3] <http://superfizyka.za.pl/>
- [4] <http://www.mentis.pl/44822-fizyka-sciaga-cz-3-liceum>
- [5] <http://wwweduscrypt.pl/fizyka-infoserw-24.html>
- [6] <http://fizyka.org/?artykul.26>
- [7] <http:lax.345.pl/t/bfb42/test-gimnazjalny.html>
- [8] <http://markaska.webpark.pl>
- [9] <http://nauka.katalogi.pl/fizyka-zadanie-t31786.html>
- [10] <http://forum.di.com.pl/showthread.php?t=5100>
- [11] <http://www.ifpan.edu.pl/kgof/menu.php>

- [12] <http://www.swietlik.edu.pl/>
- [13] <http://nauka.katalogi.pl/Fizyka:olimpiada z 95r-t7709.html>
- [14] <http://www.world.best-2006.com/website.60854.Olimpiada Fizyczna.html>
- [15] <http://notatki.wordpress.com/2007/09/10/fizyka-lekcja-2-10092007/>
- [16] <http://www.physics.umd.edu/rgroups/plasma ex.html>
- [17] <http://pingman.wrzuta.pl/film/tlDITYtTGnq/apart>
- [18] <http://forum.servis.pl/printview.php?t=4700 start=0>
- [19] <http://www.ptf.agh.edu.pl/konkurs/konkurs2006/>
- [20] <http://www.eskimo.com/ bilb/sched.html>
- [21] <http://groups.physics.umn.edu/demo/>
- [22] <http://physicslearning.colorado.edu/PiraHome/Sutтона/Sutтона.htm>
- [23] <http://www.profesor.pl/niezbdnik/nn.php>
- [24] <http://rapempire.pl/nauczyciel-dyplomowany-awans-zawodowy>
- [25] <http://panoramie.ift.uni.wroc.pl/ bosy/throw.htm>
- [26] <http://www.fiza.info/downloads.php?cat id=2>
- [27] <http://www.oerlikon.com/leyboldvacuum/rahmen.html>
- [28] <http://www.technique.pl/index.php?p=3>
- [29] <http://www.antykwariat.pl/go/ info/?id=24979>
- [30] <http://www.ifj.edu.pl/lib/cat/katalog.php?lang=pl>
- [31] <http://www.if.us.edu.pl/if/popularyzacja.htm>
- [32] <http://www.fuw.edu.pl/ ajduk/Public/whaticern.html>
- [33] <http://outreach.web.cern.ch/outreach/en/Visits/Nitro-en.html>

- [34] <http://www.amasci.com/emotor/chargdet.html>
- [35] <http://www.myzlab.pl/hv/ttesli/>
- [36] <http://www.ftj.agh.edu.pl/wolny/>
- [37] <http://forum.wsei.lublin.pl/viewtopic.php?f=22=t=1523>
- [38] <http://zpk.u.lodz.pl/polish/linki.html>
- [39] <http://publikacje.profesor.pl/mat/n14/pokaz/material/tmp.php.plik=n14/n14.m.wozniak04>
- [40] <http://www.ksiegarnia.org.pl/katalog/fizyka-4-100.html>
- [41] http://www.humor4u.info/i.php/zludzenia_optyczne/1/
- [42] <http://www.zs4.stalowawola.pl/fizyka/ciekawostki.html>
- [43] <http://forum.servis.pl/viewtopic.php?p=38815>
- [44] [http://pl.wikipedia.org/wiki/Dyspersja_\(optyka\)](http://pl.wikipedia.org/wiki/Dyspersja_(optyka))
- [45] <http://postpy.fuw.edu.pl>
- [46] <http://www.edupress.pl/fizyka-w-szkole.php>
- [47] <http://cmf.p.lodz.pl/mpfiz/efiz/licznik.html>
- [48] <http://fizyka.kopernik.mielec.pl/fizyka/Bibliografia>
- [49] <http://ptf.fuw.edu.pl/>
- [50] <http://www.aps.org/>
- [51] <http://nsearch.eu/serach.php/query=fizyka20w20sporcie>
- [52] <http://www.antag.pl/go/serach/idx/3020100/mot/Fizyka/t/1/go.htm>
- [53] <http://www.sciencedirect.com/>
- [54] <http://www.scirus.com>