

Galileo on our web textbook on behalf of International year of astronomy 2009

Robert RepnikFaculty of Natural Sciences and
Mathematics

University of Maribor

Koroska cesta 160, 2000 Maribor,
Slovenia

robert.repnik@uni-mb.si

Milan AmbrožičFaculty of Natural Sciences and
Mathematics

University of Maribor

Koroska cesta 160, 2000 Maribor,
Slovenia

milan.ambrozic@ijs.si

Vlado GrubelnikFaculty of Electrical Engineering
and Computer Science

University of Maribor

Smetanova ulica 17 Maribor,
Slovenia

vlado.grubelnik@uni-mb.si

Abstract. *In the year 2009 we celebrate the 400th anniversary of the Galileo's important observations in astronomy, thus it is declared as the year of astronomy, under the guidance of UNESCO. Galileo made his own refracting telescope in 1609 and he was able to see more details on the Moon than anyone before him: mountains, valleys and craters. In the following years he made several other discoveries in astronomy, for instance the moons of Jupiter, the phases of Venus, etc., all of which aided for the heliocentric model of Solar system. We have written a web textbook in Slovene to encourage young people, at all levels of education, to learn about the Galileo's important contributions to the development of modern science. Despite the fact that today we witness the web 3.0 technology, the web textbook is still a popular didactic tool which incorporates multimedia elements, simulations, etc. Our web textbook focuses on three aspects: Galileo's life, his scientific work and its connection to physics, and the opinion of other scientists about him.*

Keywords. Web textbook, astronomy, refracting telescope, International year of astronomy 2009.

1 Introduction

Web textbooks (other names: electronic textbooks or e-textbooks, online textbooks, digital textbooks, etc.) are becoming widespread and increasingly popular as a category of the distance-learning tools, particularly

for students, but their acceptance is still limited [1-3]. Their advantage in comparison with printed books is manifold: 1) easy user/textbook interaction with possibility of animations, 2) quick access to information, 3) larger autonomy of the user, 4) several links to interconnected topics 5) ecologically suitable (decreased consumption of paper), if only a few points are listed [4-6]. A web textbook may be regarded as an auxiliary material in addition to specialized books and magazines on one hand, but it may as well present the main learning tool, depending on the wideness and deepness of the presented theme. There is a huge amount of stuff in different forms in the area of astronomy and natural sciences, not only in English but also in Slovene.

The year 2009 has been declared as the International year of astronomy by Unesco. It is the 400th anniversary of the first Galileo's important and revolutionary contributions to the further development of astronomy. Galileo's work influenced the human view of the Universe and accelerated the development of proper science. There are numerous representations of Galileo's life and work on web pages in english [7,8], but the extent of the corresponding web literature in Slovene is relatively poor [9,10]; here we mention the Slovene web pages [11,12].

On behalf of this anniversary we set ourselves a task of building the Slovene web textbook about Galileo and astronomy, with the help of available literature, either on web pages [7,8,10-13] or as printed books [14-16]. Another motivation for this task is our university program: the students of educational physics, i.e., future physics teachers in primary and secondary schools should acquire some knowledge of history of the physics. Galileo gave

important contribution not only to astronomy but also to physics and science research approach in general and so our web book is a good opportunity to fulfill this educational task. In the following sections we first briefly mention some general concepts of the web textbooks that suit our purpose. Then the main facts about Galileo's life and work are given together with the contents of our web textbook, with the focus on his important discoveries, both in astronomy and in other scientific disciplines. Finally, we give a list of our student's comments on the book.

2 Computer-science and didactic concepts of web textbooks

According to public investigations among students it is obvious that the term web textbook (or alternative synonym) is not generally clear, nor are the wishes and demands what such books should offer [1]. In a broader sense the web textbook (better: e-textbook) may be also held on a disc, but the computer should be connected to the internet, so that the links to relating topics on web pages can be used.

Recently, the interactive multimedia e-learning material emerged with full interaction between the user and computer as possible [17,18]. Increase of the student's ability to recognize, analyze and interpret is claimed to be the biggest advantage of these e-textbooks. Visual thinking is stressed. But since only about 35% of the people are visual type we do not need to pay too much attention to the visualization and interaction at all costs. Therefore, we have not decided for this kind of textbook. In addition, our main goal was not to train students' learning competences, but merely to give to introduction of Galileo as an additional interesting reading.

The collaborative work between professors and students in building up web pages and textbooks has become popular [19]. The level of inclusion of the students in the work may vary from testing the web textbook and giving suggestions to modifying the pages on their own. The allowance of full access to the creation of the textbook is accompanied by the danger of mistakes and misinterpretations in the explanations. In our case, we have chosen something in-between: a few students prepared the initial interface and design of the textbook. Then, the reviewed text was inserted by professors of physics and didactics of physics, with the appreciation of interesting students' suggestions. Finally the incorporated students had the task to find and make links to existing web pages related to our subject. Afterwards, the textbook was tested by a larger number of students in order to collect their opinions. Finally, the book was refined. Since we did not go into the deepest level of interface/user interaction and the collaboration of students in preparation, we did not use the advantages of web 2.0 technology [20].

Web textbooks in common stimulate some general competences of pupils and students, first of all the ability of collecting information from different sources and their analysis and structural organization. What is even more important, studying web pages means a self-dependence and individualization in the pupils/students work. From didactic point, the variation of various teaching [21] and learning methods including ICT (Information and Communication Technology) is desirable [22]. It is interesting to note that the reference [22] is related to web textbooks in two aspects: 1) it is itself a web textbook, which describes the use of computers in different areas of education, 2) description of the web textbooks is included in the contents of the reference.

The level of acceptance and using web textbooks in comparison with printed books is diverse: it depends among other things on age, gender, educational level and type of learning. For instance, the students of computer science accept web textbooks more widely [1]. The researches described in [1] also indicated some reasons for not using web textbooks more widely. For most people it is easier to read from the paper than from the screen and besides this paper is also a part of long human tradition. In addition, we should not overlook the fact that paper enables using gestures (underlining key words by pencil, etc.) which facilitate memorizing. On the other hand, students in the test did not use the facilities of web textbooks (links, animations, jumps between topics, etc.) to a satisfactory extent. The authors of these didactic experiments concluded that the electronic textbooks should be an extension of printed books, but not the replacement.

The structure of the web textbook is of utmost importance. The number of sections must be limited and it is better to divide them into several subsections. Each page of the web textbook should contain a small index or table of contents. However, by our opinion, the number of menu or redirection buttons should be kept at minimum since too many buttons tend to irritate the user. Based on our experiences we recommend up to 7 items in one division (sections, subsections, etc.) and no more than 4 levels in depth in the table of contents if this table is organized like in Galileo web textbook.

3 Contents of our web textbook about Galileo

For better overview we shortly describe the subject of main sections of our web textbook. Galileo was born as the first child to parents Vincenzo and Giulia degli Ammannati in 1564 in famous Italian town Pisa. He studied medicine, but then he redirected his studies to mathematics, so that he finally succeeded to get the position of mathematics lecturer at the university. He became famous mostly because of his astronomic discoveries in the years 1609 and 1610. His

observations were the final important cornerstone which in the following ages destroyed the wrong geocentric point of view according to which the stationary Earth should be the centre of the Universe and all other celestial bodies should encircle it. Galileo became a part of history also because of his fight for truth and consequent suffering in his last years of life.

Galileo's most important observations and discoveries in astronomy were the following: 1) mountains, valleys and craters on the Moon, 2) phases of Venus, 3) Jupiter's moons, 4) explanation of tides, 5) solar specks, 6) division of Milky way into countless number of individual stars. But he also made some important scientific contributions to the mechanics, in particular the kinematics of pendulum and falling bodies. Galileo appreciated Archimedes' work and was the first scientist after this ancient Greek scientist who again performed systematic experiments to study natural phenomena. He was also enthusiastic about mechanical devices and invented some of them by himself. His own refractory telescopes should be mentioned among them. He made his first telescope in the summer 1609, with several improvements till the end of the year, and this enabled him to see the irregularities of the Moon's ideal spherical shape in autumn 1609.

Galileo wrote several books about his findings, among which the following three should be particularly mentioned:

- Sidereus Nuncius (Starry Messenger)
- Dialogo Sopra I Due Massimi Sistemi Del Mondo, Tolemaico E Copernicano (Dialog about Two Main Universal Systems, Ptolemaic and Copernican)
- De Motu (About Motion, unfinished book)

The second book was written in Italian rather than in Latin. It was this book that caused a fateful dispute between Galileo and the pope Urban VIII in 1632.

The preparation of our web textbook about Galileo was started in November 2008. It was presented to students in April 2009 and after receiving their comments (see next section) it was completed in April and May. Minor changes and embellishments are still in progress. We have divided the book into the following sections with subsections:

- Home page with short introduction (Fig. 1)
- Biography
 - Scientific work
 - Galileo's teachers, coworkers and students
 - Publications
 - »De motu« (about movement)
 - Writers about Galileo
- Development of Astronomy
- Technology
 - Telescope
 - Pendulum
 - Sector
 - Thermometer

- Pump and hydrostatic balance
- Observations
 - Moon
 - Phases of Venus
 - Solar specks
 - Saturn
 - Jupiter's satellites
- Theory of tides
- Mechanics

There is a table of contents on each page to ease the reader's navigation through the text. The pages are supplemented by photographs and drawings, in particular in the description of Galileo's telescopes and astronomic observations. Some additional information about astronomical and physical concepts is added in the text in order to refresh the reader's knowledge. The reader may also find interesting the thoughts of scientists and other famous people about Galileo, that's why the subsection »Writers about Galileo« has been added to Bibliography section.

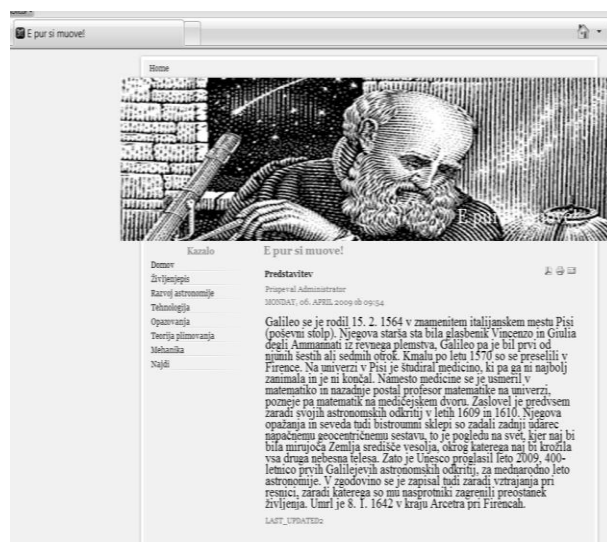


Figure 1. Home page of our Galileo's web textbook.

4 Students' comments about the use of our web textbook

At the beginning of April 2009, our web textbook on Galileo (hereafter called »book« for brevity) was presented to our students of educational physics in the 2nd and 3rd year of study as a kind of didactic experiment for the following reasons:

1. Students in the 2nd year attend the subject »Electromagnetism with optics« and it is recommended for them to see some direct application of the subject's theory (optics in the use of telescopes).
2. Students in the 3rd year attend the topic »physics history« within the subject »Didactics of physics I« and the historical description of Galileo's work as well the

development of astronomy is a good example of the topic

Students gave several positive opinions about the use of the book:

1. The book is a welcome variegation of the didactic tools in their study.
2. Individual work is supported and everyone can find some topic within the book at will to supplement his/her knowledge.
3. Common computer tools can be used with the web book in contrast to printed books, for instance, variation of the text size which is convenient for readers with bad eyesight.
4. Navigation through the topics is easy and comfortable. In particular, navigation to external web pages is appropriate (they open a new window for the link): when one reads the linked web page and is not interested in it any more, he/she simply closes the page while the Galileo's book is still open. It is convenient that the index shows only the main sections of the book and the subsections are shown only after the mouse-click on the section of interest. This keeps the index from being too lengthy.
5. Various subjects and topics are well interconnected via several links.
6. Internal structure of the book has been chosen reasonably. On one hand the complete Galileo's story can be acquired through linear access of the book, while on the other hand the reader can focus on a particular segment and study it more detail through the links. Furthermore, the web textbooks like this can be very useful for students in looking for ideas for their seminar texts.
7. When the students prepare for near-coming exams there may be a lack of available hardcopy books in the faculty libraries, thus web textbooks may be helpful.
8. There is always a possibility of simple online changes and upgrade of web textbooks. Students have written many very interesting seminar texts and the wish of many of them is to reward their efforts by including their texts to web pages. Thus, the texts more or less connected to Galileo could be easily included in our book.
9. When these students become teachers, particularly in primary schools, they will know where to find the book on Galileo in slovene on internet, so that they will be able to use it in school practice.

There were also a few criticisms of individuals about the book:

1. The text is too lengthy.
2. There should be many more interconnections with other scientists' work. We have included only the work of a few scientists, either predecessors or contemporaries of Galileo who had the most important influence on the development of astronomy.
3. Although the students as future teachers will be able to use the book as an interesting additional source for lecturing in primary and secondary schools, they find difficult to use the book directly in the frontal form of lessons.

Since according to our philosophy of the meaning of such web book we could not entirely appreciate these criticisms in finishing the book we gave the explanation of our point of view to the students. For instance, the length of the text should present no difficulty to students who are expected to have developed reading skills. Furthermore, the aim of the web textbook is not using it as a direct tool for frontal teaching.

5 Conclusions

The year 2009 is the International year of astronomy (by Unesco) and the 400th anniversary of Galileo's first observations crucial for further development of astronomy and science. On behalf of this occasion we have built our Slovene web textbook about Galileo's life and work. We stress the following points of the textbook:

- It has been made in cooperation with students.
- It has been tested by students.
- It is useful for two subjects in educational physics at our faculty.
- It is interesting as supplemental literature for primary and secondary school.
- Its contents are reliable, but on the other hand there is a small degree of interaction between the user and computer. The responsibility for upgrading the web textbook is on the system administrator.

The working web address of the textbook is at the moment:

<http://lizika.pfmb.uni-mb.si/observatorij/projekti/Galileo/>

6 Acknowledgements

We greatly acknowledge the support of the Ministry of Education and Sport of Republic of Slovenia and the European Social Fund in the frame of the project "Development of Natural Science Competences", No.

OP 13.2.3.1.12.0001, at the Faculty of Natural Sciences and Mathematics, University of Maribor.

References

- [1] Lau J: **Students' experience of using electronic textbooks in different levels of education**, Scroll, Vol. 1, No. 1, 2008, available at <http://jps.library.utoronto.ca/index.php/fdt/article/viewArticle/4907/1768>, Accessed: 20th April 2009.
- [2] Sandia National Laboratories: **Sandian's Web-based computational science textbook used in 100 schools**, available at <http://www.sandia.gov/media/webtext.htm>, Accessed: 20th April 2009.
- [3] Hofstetter F T: **Internet technologies at work**, Irwin Professional Publications, Chicago 2004.
- [4] Niederst J: **Web Design in a Nutshell**, O' Reilly, 3rd Edition. 2006, ISBN 0596009879.
- [5] Smith-Atakan S: **Human-Computer Interaction**, Thomson, 2006, ISBN1844804542.
- [6] Shneiderman B: **Designing the User Interface: Strategies for Effective Human-Computer Interaction**, Addison-Wesley, 3rd Edition 1998, or 4th Edition, with C Plaisant, 2004, ISBN 0321200586.
- [7] Van Helden A: **The Galileo Project**, available at <http://galileo.rice.edu/>, Accessed: 10th November 2008.
- [8] JOC/EFR: **Galileo Galilei**, available at <http://www.gap-system.org/~history/Mathematicians/Galileo.html>, Accessed: 10th November 2008.
- [9] Repnik R, Vajngerl V, Krašna M: **Virtual learning environments**, MIPRO 2006, 29th International Convention, Opatija, Croatia, 2006, proceed. Vol 4, Computers in education, pp 92-94.
- [10] Pedagoška fakulteta Univerze v Mariboru, Oddelek za fiziko: **Virtualna šola astronomije**, (Virtual School of Astronomy), available at <http://lizika.pfmb.uni-mb.si/observatorij/projekti/virtualnasola/sola/index.htm>, Accessed: 10th November 2008.
- [11] Wikipedia (Slovene translation): **Galileo Galilei**, available at http://sl.wikipedia.org/wiki/Galileo_Galilei, Accessed: 10th November 2008.
- [12] Kvardakabra: **Galileo Galilei – med mitom in zgodovino**, available at <http://www.kvardakabra.net/article.php/Galileo-Galilei>, Accessed: 10th November 2008.
- [13] DMFA: **Mednarodno leto astronomije**, available at <http://www.astronomija2009.si/>, Accessed: 20th April 2009.
- [14] Čermelj L: **Astronomija**, Mladinska knjiga Ljubljana, 1970 (slovene translation of the book: Fred Hoyle, Astronomy - © Rathbone Books Limited, London 1962).
- [15] Asimov I: **Biographic encyclopedia of science and technics**, translation into slovene by several translators, Tehniška založba Slovenije, 1978.
- [16] Strnad J: **Fiziki I** (Physicists I), Mihelač in Nešović, Ljubljana 1995.
- [17] Jirousek C A: **An Interactive Electronic Design Textbook on the World Wide Web**, available at <http://www.itaaonline.org/downloads/Monographs/Monograph8-pt%202.pdf>, Accessed: 20th April 2009.
- [18] Pearson R: **Microelectronic Webucation, Using the World Wide Web to Provide Educational Material on Microelectronic Process Engineering**, IEEE, available at <http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=00630727>, Accessed: 20th April 2009.
- [19] Krause S: **World Wide Web**, available at <http://www.emunix.emich.edu/~krause/Tips/WWW.html>, Accessed: 20th April 2009.
- [20] Wikipedia: **Web 2.0**, available at http://en.wikipedia.org/wiki/Web_2.0, Accessed: 20th April 2009.
- [21] Repnik R: **Priložnosti za vnašanje sodobnih znanstvenih dognanj v pouk osnovnošolske fizike** (Opportunities for inserting of modern scientific knowledge in the teaching of elementary physics), IV. Mednarodno znanstveni posvet na temo Ekologija za boljši jutri, RIS Rakičan, March 2009.
- [22] Gerlič I: **Model uporabe računalnika v izobraževanju** (Model of the use of computer in education), available at <http://iris.pfmb.uni-mb.si/old/ivan/model98/index.html>, Accessed: 20th April 2009.