

# THE HISTORY OF PHYSICS COURSEWARE

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## Abstract

*The History of Physics* web courseware (CW) was designed as an outcome of a collaborative work of students and teachers. Its content, as well as its graphical and instructional design was prepared to suit pupils, students and physics teachers. Lessons follow the development of physics through time and its fields. CW includes a time axis, a dictionary, a help function, a clickable application map, references and links, communication via web forms, multimedia elements and a quiz. CW, as an example of good practice and project teaching, is available in Croatian language at <http://ahyco.ffri.hr/povijestfizike/>.

## 1. Introduction

In the context of a course „Hypermedia supported education“ at the Physics and Information Science undergraduate program at the University of Rijeka, a hypermedia e-learning WWW application or courseware on the *History of Physics* was developed. The educational content is the result of teamwork achieved by four students, guided by two teachers of Information Science and Physics. The students, as a part of their assignment, developed an extensive web courseware on the topic of history of physics, and during the development the students have applied the acquired knowledge of good web and instructional design, as well as included various multimedia elements, online quizzes and communication tools. Excellent project results motivated the authors to further improve the web courseware. It was turned into an educational content which could be used not only by students of the *History of Physics* for learning purposes, but also by other physics teachers and their pupils to facilitate teaching at the primary and secondary level. To meet that goal, the courseware was enriched with various content, adjusted texts, quotations, additional materials, and images; with addition of improved design and navigation system. The text in Croatian language is methodologically edited. The courseware is available to users in Croatian language at <http://ahyco.ffri.hr/povijestfizike/>.

## 2. Courseware content and its elements

The aim of developing this courseware is to familiarize the user with the development of physics through history, to facilitate the process of learning physics, and to represent physics in a different, more interesting and dynamic way than the classic sources of knowledge do.

Historical content is organized chronologically into chapters covering the most important historical periods in the development of physics: Antiquity, Middle Ages, Renaissance, Modern Age, 19<sup>th</sup>/20<sup>th</sup> century and 21<sup>st</sup> century (Fig. 1.). Each chapter, i.e. period, begins with an introduction which provides basic information about the period from general history, the length of the period and main ideas from that time. What follows are the subchapters which describe physics development by fields of physics: the Philosophy of Nature, Mechanics and Astronomy, Optics and Waves, Electricity and Magnetism, Heat and Structure of Matter.

In chapter 19<sup>th</sup> century Heat is extended by Statistical Physics, and chapter 20<sup>th</sup> century has the following subchapters: the Theory of Relativity, Quantum Physics, Atomic and Nuclear Physics, Quantum Field Theory and the Physics of Elementary Particles. Even though the primary organization is chronological, the user can follow the development of physics through each historical period separately or the development of a particular field of physics through all periods.

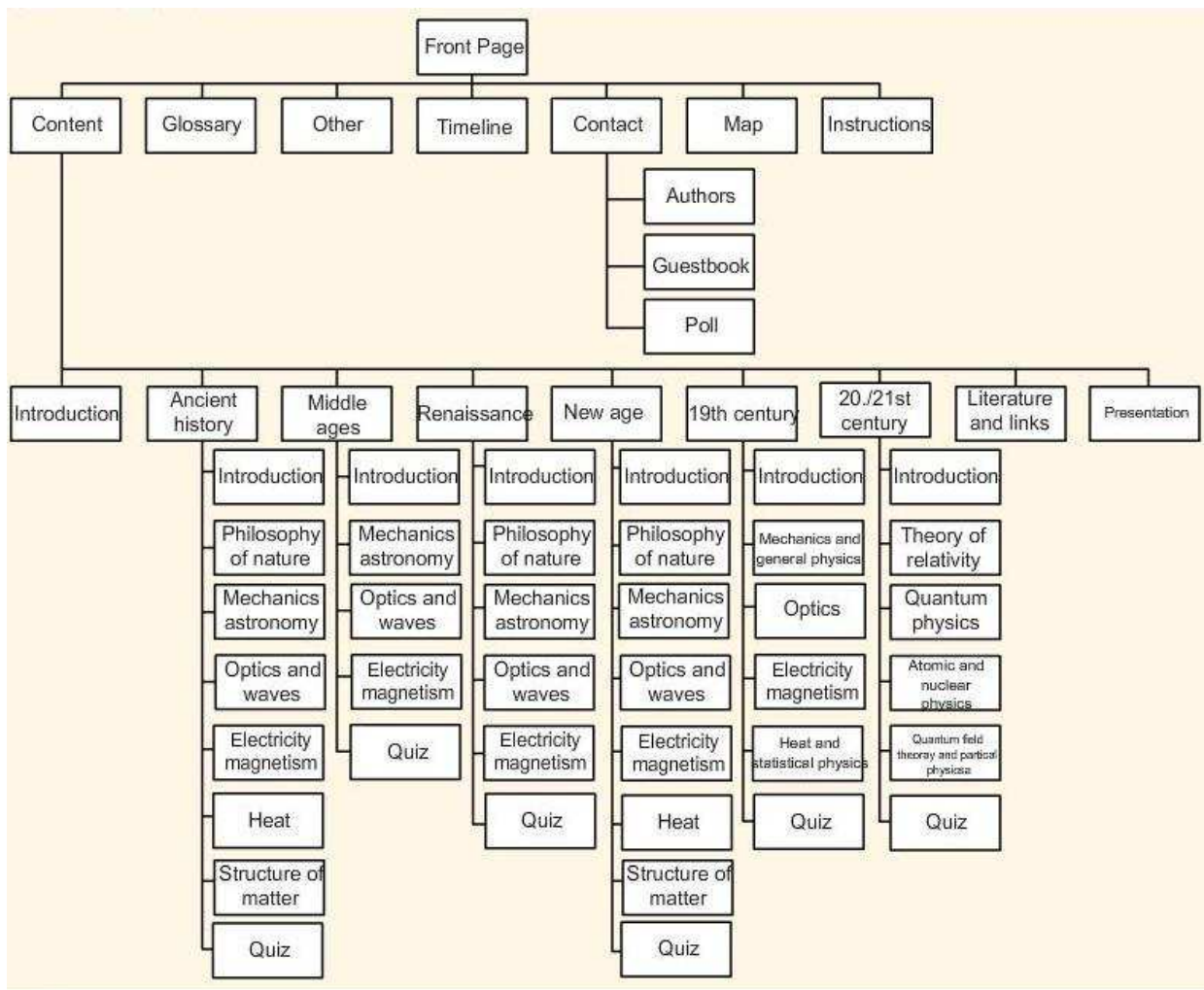


Figure 1: Map of the courseware

The historical development of periods of physics is described through an overview of relevant events, discoveries and thinkers. The first occurrence of a physicist's name is marked in bold, with reference to his/her date of birth and death. The titles of the most prominent works in the history of physics are listed throughout the entire courseware, translated to Croatian language, with the original title in brackets. The pages are visually enhanced by myriad images, and the graphical outlook is improved by quotes of famous physicists or anecdotes, which are framed or marked in cursive. These are implemented into the content as direct authentic and witty testimony of the time and people, with the purpose of illustrating the specific period, discovery or inventor, and of making the content more interesting and dynamic.

*The History of Physics CW* has standard elements characteristic to every courseware: attractive design of the front page as the entry point into the courseware, content, i.e. list of links to all lessons, interactive graphic map, a glossary, instructions for use, list of references and links, tools for communication between users and authors/ teachers and elements for knowledge assessment. At the end of each period, i.e. chapter, one can find an interactive quiz with ten multiple choice questions for assessing the user knowledge. After taking the quiz, the user is provided with feedback in the form of a percentage, and the information about correct answers.

The alphabetically organized glossary shortly defines physics terms which are named after physicists, e.g. Doppler Effect, Faraday's Law of Electromagnetic Induction, etc.

The courseware content is formed as a list of links to all chapters and subchapters. The interactive clickable map also contributes to easier navigation. It graphically represents the hierarchy of the courseware, i.e. chapters, lessons and other elements. The courseware also contains a timeline with marked years of the most important historical events and years of great historic discoveries in physics.

The main menu also offers a page with references and numerous links intended for further knowledge. The instructions for use consist of basic information about the courseware with an emphasis on element description and navigation rules through the contents. The page "Additional material" is organized as a sort of courseware repository. It contains student presentations from previous academic years in which the *History of Physics* course was held, in PDF format.

Communication with authors or teachers is possible in three ways: via e-mail (the address is: [povijest.fizike@gmail.com](mailto:povijest.fizike@gmail.com)), via guestbook, where visitors leave their comments using a web form, and a pool, where the aim is to examine the user satisfaction with the courseware.

### 3. Phases in developing the courseware

In developing the courseware it was important to decide which type of instructional design will be used. As in any type of teaching, on-line education can also use several development models. Each model has the following in common: defining objectives, designing a working plan, selecting educational content and determining its sequence and structure, deciding on how course materials will be presented and which teaching methods used.

This courseware was primarily designed as an assignment for a study course. Strict guidelines of development stages were respected. It was team-work with a clear division of tasks. The first stage focused on the basic elements: the exact subject matter of the courseware, users, software to be used, and the division of work. The second phase involved the development of storyboards. Storyboard is a graphical and textual presentation of all the information to be displayed on the program screens, and which develops the initial idea and represents a combination of written descriptions, drawings, block diagrams describing all the elements of the application. The basic design elements which will be used are clearly presented, as well as the site map, sketch and description of the page, with basic navigation and graphic elements. At the end, an individual and group report with a detailed analysis of the development process is provided.

To create this courseware a design model **ADDIE** (Analyze, Design, Develop, Implement, Evaluate) was used. When analyzing, it is important to determine the characteristics of users and their educational needs as well as to define objectives and tasks to be performed. The design involves planning of educational objectives, content, lessons, teaching methods, modes of assessment, and on-line technologies for displaying content and communicating with students. The development refers to acquiring and preparing technologies for content presentation and interaction with users. The implementation involves uploading the on-line content.

Evaluation is a process conducted throughout all of the courseware development phases, and upon its completion. In addition to testing and evaluating the technical side which ensures that all the elements work together and are displayed to users properly, an educational evaluation specific for the courseware is also necessary.

Evaluation of the educational side determines whether the educational objectives have been achieved, and refers to how users accept the program and what should be done to improve the program in the future. The courseware needs to be shown to users who then should be asked for their opinion about various elements of the program and its content.

After a successful completion of the course assignment and the evaluation by teachers of Informatics (technical part) and Physics (content), further testing of the courseware was done. It was presented to the rest of the students and teachers from the Department of Physics and Informatics. After their evaluation, the courseware was redesigned which changed some graphic elements, added animation, etc. Based also on users' suggestions (in interviews and through the very positive comments in the guestbook) it was decided to adapt the courseware content for a wider group of users. Several proof-readers and physics teachers reviewed all articles, added new literature and expanded content. Some images were also changed because of copyright protection. Subsequently, it was uploaded online again and it still successfully serves its purpose even though further maintenance and improvement is planned.

### 4. Courseware design

*The History of Physics* web courseware was created in the context of the course "Hypermedia Supported Education". During its development, student-authors used knowledge acquired through the following courses: "Computer networks", "Internet Programming", "Multimedia Systems" and "Methodology of Teaching Information Science". It was developed using the Macromedia Dreamweaver 8 which is used as a web design tool. For developing interactive elements of the

courseware, such as the pool and guestbook, dynamic programming in PHP language was used. Quizzes were developed in javascript. Considering students were beginners in developing web presentations, and because of its simplicity, tables were used for the design of the page interface instead of CSS.

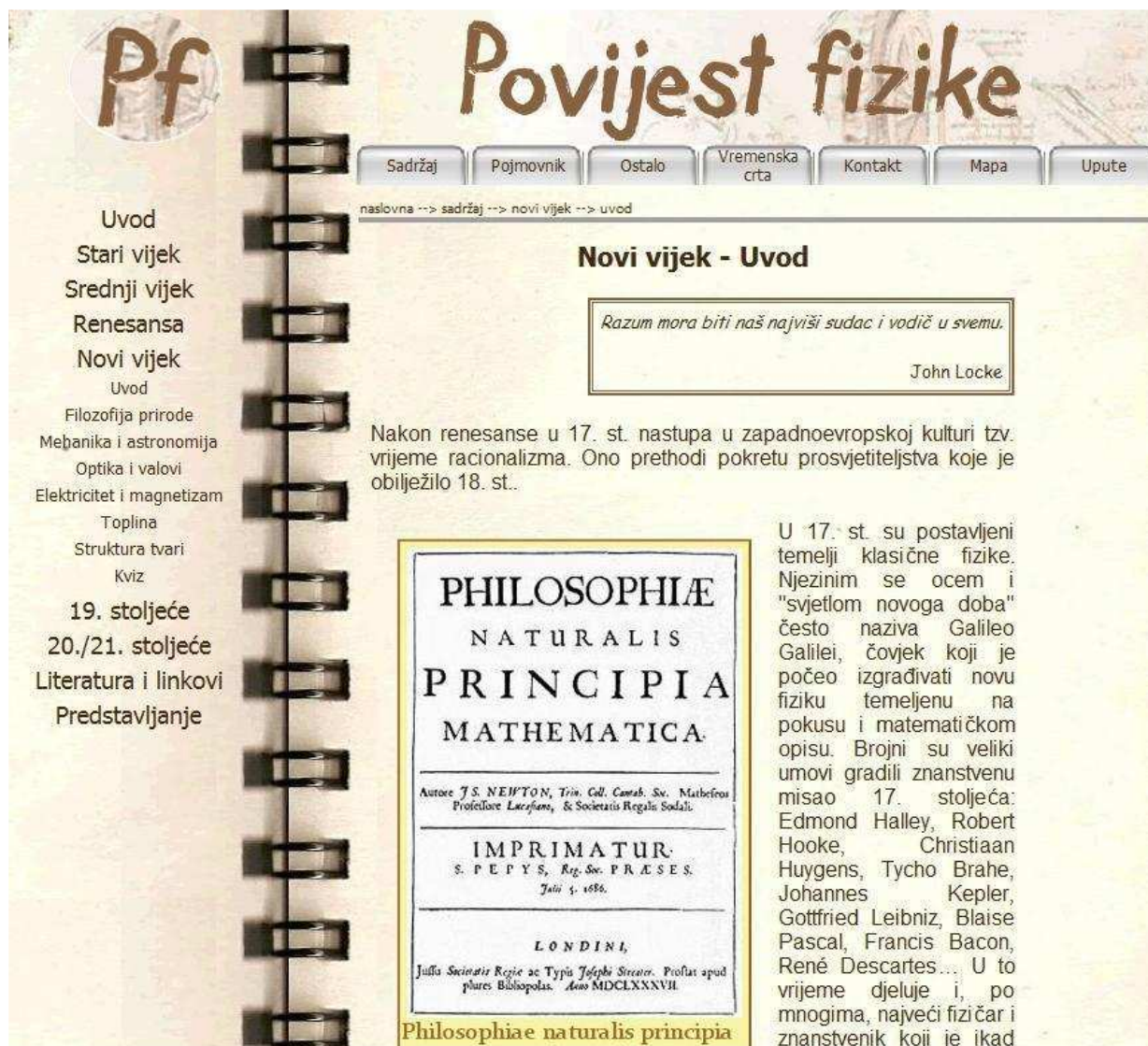


Figure 2: Example of web page design

The graphical design is based on a background created by scanning a notebook, which is a metaphor for learning and studying. Other graphical elements such as letters, colours, arrows and images are adjusted to the historical theme; these are in brown and dark hues which create a resemblance to parchment paper (Fig. 2.). For the basic design an even simpler CSS was used in Dreamweaver with already set basic elements such as colour, table background, font and font size. The front page of the courseware contains an introductory clip on the development of physics from antiquity to the present time. The clip is created in Windows Movie Maker, touched up and completed in Macromedia Flash. This tool was also used for the timeline and page map. The creation of title, logo, background image and image processing were performed using Gimp 2.6.1. and Macromedia Fireworks.

To facilitate the process of navigation in the courseware, several types of navigation were used, as an extremely important element of the courseware. The primary navigation is below the title and has the main elements: content, map, glossary, timeline, instructions, repository of additional content and contact information. On the left side of each page is a secondary vertical navigation with the list of all time periods. By clicking on these periods, a submenu is opened with a list of physics fields described in this period. For easier linear navigation through the content, every page

contains an arrow at the bottom which navigates through the same historical period. The right side of the page holds a panel with links to other historical periods in which accomplishments from the same field are mentioned. Another way of navigating through the courseware is enabled by the popular breadcrumb navigation, which is set below the primary navigation.

## 5. Users

The courseware was presented on several conferences in Croatia and Slovenia and at the University of Lubiana. Well-known national educational portals have put hyperlinks to this courseware (E-school of physics and Carnet's school portal). It has been published as a link on several articles in the Croatian version of Wikipedia. It is used by students of the History of Physics at the University of Rijeka and other universities in Croatia. It is also used by teachers and pupils from Rijeka's high schools. It is important to emphasize that this is a unique electronic material in Croatian language which is its greatest educational significance. The purpose of developing the courseware was to enable more users to use it and access information faster.

## 5. Conclusion

*The History of Physics* courseware is developed as an educational material with the intention of supporting e-learning of the "History of Physics" course at the University of Rijeka. By its content, and methodological and design interventions, the courseware is transformed into an educational material intended for a wide group of users - students and teachers at the primary and secondary level of education. It can serve as an e-textbook for students and a sort of e-manual for teachers, but also as an additional source of knowledge on the historical development of physics.

Due to its online form and the usage of multimedia, the courseware enables a more dynamic approach to content, one which young people can easily relate to, and even manage it better than classic printed sources of knowledge. In this way, the courseware is also intended for the general public, for all those interested in passing through the virtual space, who maybe do not strive towards understanding physics itself, but are rather interested in finding out more about discoveries and their historical surroundings. With this in mind, the authors believe that the courseware attributes to the overall popularization of physics.

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