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Exploring Magnetism through a Web-Based Educational and Research Tool

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Abstract: *The objective of this study is to develop an online information database on magnetism, accessible through the web interface http://magworld.physics.auth.gr. This platform serves as an educational and research tool, providing comprehensive resources on magnetism. It consists of three main sections: (a) historical background and fundamental concepts to facilitate a deeper understanding of magnetism, (b) collection, categorization, and evaluation of magnetism-related scientific information published in prestigious international journals and books, and (c) an interactive section exploring the interaction of magnetic fields with various materials through experiments, online estimations, and quizzes. The platform is designed for a wide audience, including physics students, educators at all levels, and individuals with a general interest in magnetism, regardless of their scientific background. By offering structured, reliable, and interactive content, this web-based resource aims to enhance learning, stimulate curiosity, and promote a deeper appreciation of magnetism's principles and applications, making it an invaluable tool for both academic and independent exploration.*

Keywords: *magnetism, magnetic properties, magnetic materials, magnetic applications*

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I. INTRODUCTION

The electronic search for scientific information in specific fields is an easy-to-use tool that, in combination with the evaluation of the collected information for its correctness and validity, greatly facilitates scientific studies (Kalogiannakis et al. 2018; Hirano & Hirokawa 2017). The continuous updating and enrichment of data with information from modern scientific developments, such as nanotechnology and related scientific fields, contributes to the validity and reliability of scientific information collection (Zhang et al. 2021).

Magnetism is a multifaceted natural phenomenon with significant implications for education, research and technology. Its applications cover a wide range of scientific and technological disciplines, such as magnetic data storage, medical imaging (MRI), new materials development and nanotechnology (Coey 2010). The scientific literature on magnetism is available in both printed and electronic form, including theoretical analyses, experimental data and practical applications (Spaldin 2011).

The present study aims to create an organized online database on magnetism, which will include the history of the phenomenon, its basic concepts, its modern applications and the materials that exhibit magnetic behavior. The materials will be categorised according to their size scale—macro-, micro- and nano-scale—with emphasis on the latest developments in nanotechnology. In addition, the study will propose novel experimental procedures and data processing, aiming to understand the fundamental principles of magnetism and link them to practical applications (Kim & Zhao 2022).

By integrating reliable sources and systematically categorizing knowledge, the proposed online platform will help facilitate the search for information and disseminate scientific knowledge in the field of magnetism.

II. METHODOLOGY

The methodological approach of this study is based on the creation of an online database that will provide systematized information on magnetism, organized in a way that meets the needs of different users. The classification of information is based on the scale of related materials, starting from macroscopic applications, moving on to microscopic evaluation of materials and ending with nanoscale materials. In this way, each user, depending on his level of familiarity (pupils, students, researchers), can have access to personalized content that will facilitate the understanding of the principles of magnetism and its technological applications.

The development of the web platform includes the collection, evaluation and categorization of scientific data from authoritative sources, such as scientific articles, books and databases. The presentation of

information is structured in sections, where the user can explore different categories of magnetic materials, their physical properties, collective magnetic phenomena and corresponding technological applications. The dynamic structure of the website allows easy navigation and search for information, as well as the continuous updating of the content based on developments in the field of nanotechnology and magnetic materials.

In addition to providing theoretical information, the platform incorporates interactive tools that enhance its educational value. Specifically, the user has the ability to conduct online calculations of magnetic magnitudes, observe simulations of magnetic phenomena and participate in quizzes of graded difficulty, depending on his cognitive level. These features make the website not only a source of information but also an active learning tool, where the user can apply his knowledge and practice practical concepts of magnetism.

The final product is an easy-to-use, functional and bilingual (Greek/English) website, which offers a comprehensive presentation of the evolution of magnetic materials, their properties and applications, depending on their scale. The design of the website aims to provide a complete, reliable and interactive source of information on magnetism, contributing both to the dissemination of scientific knowledge and to the support of the educational process at various levels.

III. RESULTS

The development of the web-based platform for magnetism has as its main objective the unification of the understanding of the phenomenon, regardless of the size scale of the materials. Through the structure of the website, the user is gradually guided from the macrocosm to the nanoscale, maintaining a unified view of the physics of magnetic phenomena. This transition is achieved by thoroughly presenting the concepts, clarifying the physical mechanisms underlying magnetism and at the same time referring to the properties of materials and their applications (Borges & Gilbert 1998).

A key advantage of the website is the ability to easily access, without requiring specialized knowledge of magnetism. The collection and continuous updating of content allows the classification of relevant information in a way that facilitates searching. The user can navigate through different topics, find information about the properties of magnetic materials, explore magnetic phenomena and understand modern technological applications based on magnetism (Bozzo et al. 2019).

The website is primarily aimed at students and physics teachers, but has been designed in a way that allows accessibility for students of all educational levels, as well as anyone interested in exploring magnetism as a phenomenon. The interactive approach enhances the learning experience and makes the study of magnetism more accessible to a wide range of users (Gunawan et al. 2021; Jing, L., & Singh 2016; Prytz 2020).

An important addition is the integration of online quizzes, which act as self-assessment tools (Figure 2). The user can select the difficulty of the questions (easy, medium, difficult) and repeat his tests, thus enhancing his understanding. The quizzes include multiple-choice questions and a question bank that refreshes dynamically, allowing the user to test their knowledge at different levels (Cooper et al. 2006).

In addition, the website includes a tool for online calculations of magnetic quantities, ranging from basic mathematical conversions to more specialized computational procedures used by researchers. The user can follow the analytical process of the calculations, understanding how the numerical results are derived. This tool contributes not only to the learning but also to the practical application of theoretical knowledge, allowing an experiential approach to the study of magnetism.

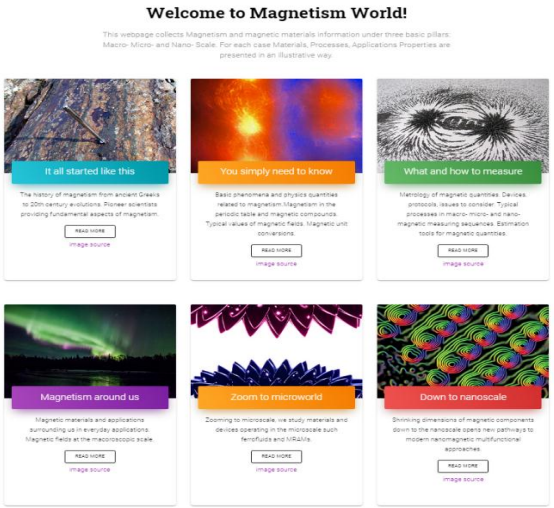

Fig.1: The main http://magworld.physics.auth.grwebsite includes 6 main information areas: It all started like this, You simply need to know, What and how to measure, Magnetism around us, Zoom to microworld, Down to nanoscale.

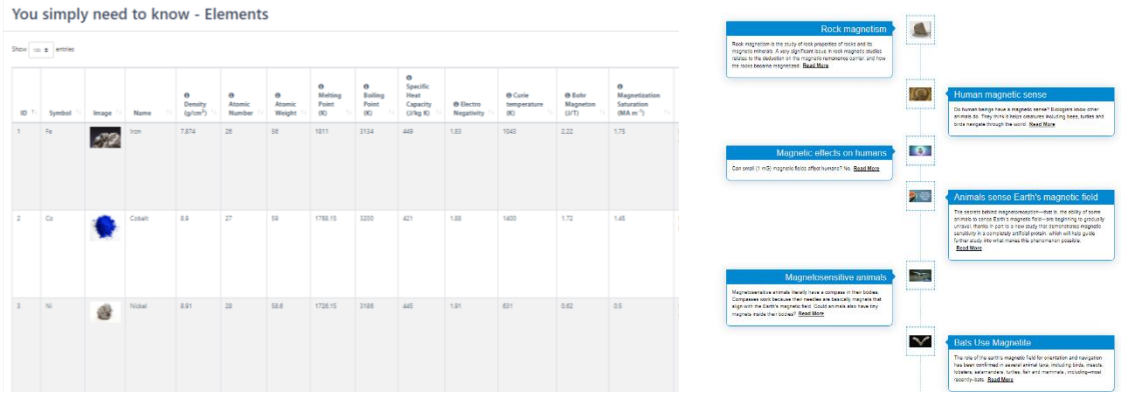

Fig.2: In the category You simply need to know you can find information about the elements of the periodic table (Elements) regarding their magnetic characteristics while the option Fact & Figures includes 3 information areas depending on the size scale: Universe, Earth, Life.

In each category of magnetic materials (macro-, micro- and nano-scale), the platform has an extensive database of questions covering both basic principles and more specialized aspects of magnetism. The general quiz, which includes questions from variousthematic units, gives a complete picture of the user's understanding and is a useful tool for the consolidation of the material.

Overall, the online platform is a functional, user-friendly and educationally efficient tool, which offers comprehensive information on magnetism, promotes interactive learning and contributes to the dissemination of scientific knowledge to a wide audience.

IV. CONCLUSIONS

The present study developed and presented an interactive tool for the study of magnetism, which covers all dimensions of the phenomenon, from macroscale to nanoscale. The online platform was designed in a way that allows the provision of information through various presentation formats, while incorporating interactive elements that enhance the learning experience. In this way, the website is not limited to students and physics teachers, but is also addressed to young students, experienced researchers, as well as anyone interested in exploring magnetism out of pure scientific curiosity.

The platform's dynamic approach to learning proves to be particularly effective, as it allows users to interact with the content through activities such as online calculations, quizzes and magnetic simulations. This methodology not only facilitates the acquisition of knowledge but also acts as a powerful incentive to maintain users' attention and interest. Interaction with digital learning tools is considered a modern approach adapted to the technological requirements of the 21st century, contributing to a better understanding of concepts and enhancing critical thinking.

The website is a useful tool for both educators and researchers, allowing easy access to valid and up-to-date information on magnetism. The integration of modern teaching practices and the connection of theory with practice make the platform an innovative means of disseminating scientific knowledge, adapted to the needs of modern education and research.

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