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Learning Interferometric Equipment through Integration of Game Methods into Mobile Application

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Abstract

The article focuses on the research and development of a mobile application for basic and advanced study of interferometric equipment. Based on modern approaches to education and actual needs of students, the peculiarities of operation with high-precision interferometric equipment were investigated. The article examines the problems associated with studying the interferometry as a discipline: the difficulty of understanding the terminology, the uniqueness of the application base, and the limited number of students. To solve these problems, it is proposed to involve game-based learning methods, which makes the process more immersive and effective. The application, developed on the basis of the Unity platform, aims to make the study of interferometry accessible, interesting and effective, combining theoretical knowledge with practical tasks and game elements.

Keywords: interferometry; mobile application; educational tool; game methods; high-precision equipment.

1. Introduction and statement of the problem

Interferometry, which is based on the phenomenon of light interference, is one of the most accurate and reliable methods of optical measurements. Interference occurs when two or more waves coincide in such a way that they mutually amplify or cancel each other. This phenomenon is the key one for interferometry and forms the foundation pillar of high-precision measurements in modern technologies of Industry 4.0 [1]–[2].

The study of interferometry as an essential part of Metrology 4.0 [3]–[4] is an important component of the training of specialists in the field of optics, metrology and physics. For a few centuries, this method has been applied to study the optical properties of various materials, to study deformations, temperature changes, and other parameters. The main difference between interferometry and other methods is its high sensitivity and accuracy.

With the development of technologies including nanotechnology, interferometry received a new lease of life thanks to laser technique [5]. Lasers, with their monochromatic and coherent light, became an ideal source for interferometric studies, which greatly expanded the possibilities of the method.

However, despite the huge potential of interferometry, studying this direction can be a challenge. The main barrier is the complexity of terminology, mathematical models and physical principles that underlie the phenomenon of interference. Students often struggle to grasp abstract concepts related to the wave nature of light, phase shifts, and other aspects.

Therefore, there is a great need for modern teaching methods that could simplify and make the study of interferometry more accessible to students of various training levels. This is especially relevant in conditions where traditional teaching methods may not always be effective in the context of deep understanding and practical application of knowledge. In these contexts, the development of modern training tools such as mobile applications can play an important role in training the next generation of interferometry professionals.

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2. Problems and shortcomings

Interferometry seems to be a powerful tool in the field of measuring technology, scientific research and technological processes, including the production of power equipment, for example, high-precision installation of turbine blades on seats. However, the study and practical application of this method often face a number of difficulties and limitations.

Difficulty in understanding the terminology: Interferometry is inherent in its specific terminology that can be confusing for newcomers. Such concepts as phase shift, coherence, interference pattern can cause confusion without proper preparation.

Uniqueness of the application base: Interferometric equipment, which uses laser technology, can be expensive and require special conditions for operation. This can limit access to practical training, especially for institutions with limited resources.

Limited number of students: Since interferometry is a rather narrowly specialized field, not all students may see it as a career or research prospect. This may lead to a limited number of humans studying the subject.

Lack of didactic materials: Traditional educational materials may not effectively cover the complex concepts of interferometry. This can lead to students having difficulty in understanding key aspects and principles of the method.

Insufficient practical skills: Theoretical training is only one area of studying interferometry. Practical skills acquired while working with real equipment are an integral part of the learning process. However, access to such equipment may be limited.

Technological changes: Modern technology evolves rapidly, and what is considered as advanced technology today, may become obsolete tomorrow. Students and teachers need to constantly update their knowledge and skills to stay abreast of the latest technological trends.

Considering the above-mentioned shortcomings, there is a need for new approaches and methods of learning interferometry that could simplify the learning process and make it more accessible and effective to a wide range of people.

3. Goal of the paper

The goal of the current paper is to find ways to optimize the learning and investigating processes in the laser interferometry, which requires a deep understanding of the principles of work and the acquisition of practical skills under the conditions of continuous development and change of interferometric methods, techniques and even methodology, due to a transition from single-beam to multi-beam interferometry, from single-wave to multi-wave technology, from interferometry of nanoobjects to interferometry of space objects [6].

4. Interferometric equipment and features of its operation

4.1. Study of the interferometric equipment features

First of all, it is necessary to consider in detail how the interferometric equipment functions. What does its accuracy depend on? What factors can affect the measurement results? Answers to these questions would help the students better understand the principles of work and control possible sources of errors: systematic and random, methodic and instrumental, etc.

4.2. Involvement of game-based, visualized learning methods

Modern pedagogical approaches indicate the effectiveness of game-based learning methods [7], which contribute to increasing students' motivation, powering their interest in the subject, and deepening understanding of the course. The use of visualized simulations of interference phenomena can significantly facilitate the process of assimilation of complex concepts and laws.

4.3. Applied aspect of interferometry

In addition to theoretical aspects, the educational process should focus on practical skills that students will be able to apply in realty. In particular, this applies to working with equipment, taking measurements, analyzing results and identifying possible causes of deviations.

The main objective of this paper is to study the interferometric equipment with its features and to develop the effective teaching methods, in particular, with the help of game technologies. This approach is aimed at ensuring a deeper understanding of the learning material, increasing student's motivation and training highly qualified specialists in the field of interferometry.

5. Game methods

Due to globalization and continuous technological progress, today's students are changing their educational preferences and learning methods. Game methods, which have long been used in various relationships, have also gained popularity in the field of education due to their high efficiency and ability to encourage active participation.

Dynamics and motivation. Main advantage of game-based methods is that they use dynamism and competitiveness to stimulate interest in learning. Games can include elements of competition, achievements and rewards that encourage students to actively participate and strive to achieve their best results.

Visualization and experience. Game methods allow you to visualize complex concepts and processes. Instead of reading textual explanations, students can observe actions in real time, conduct experiments, and gain first-hand experience that contributes to a deeper understanding of the interferometry.

Adaptability. Modern gaming methods often include an adaptive approach to learning [8]. This means that they automatically adjust the level of difficulty based on the student's current knowledge and skills, helping them focus on the areas where is needed the most support.

Cooperation and interaction. Many educational games focus on group interaction and cooperation. This stimulates students to learn how to work together, discuss ideas and make the team decisions.

Diving. Thanks to the game design and interactivity, students often immerse themselves in the learning process, forgetting about distractions and focusing fully themselves on the learning material.

6. Game methods in studies of interferometric equipment

On the basis of Duolingo, the program for learning English [9]–[10], a custom program for interferometry and studying metrology has been developed. The images below show the application itself where you can log in (Fig.1), select a level and read information in the books (Fig.2), and the test, which provides options for answers; here the hearts are deducted for an incorrect answer (Fig.3).

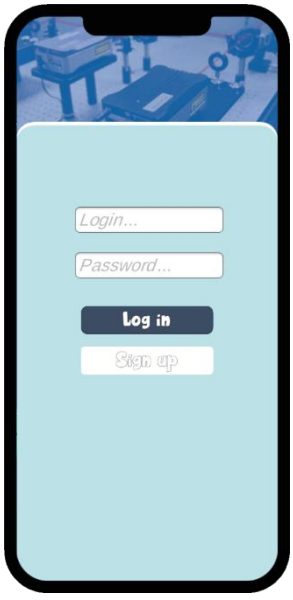

Fig.1. Fields for registration in the application.

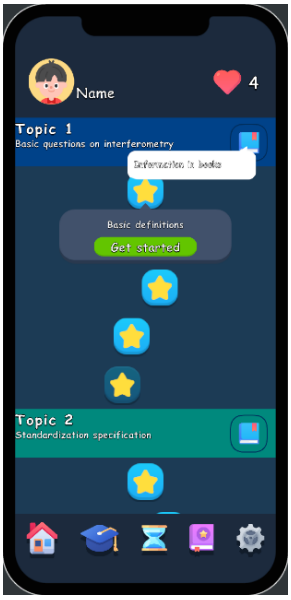

Fig.2. The main menu of the game, here you can select and start a test (game level).

Fig.3. One of the tasks.

As a result, the use of game methods in the educational process significantly increases the quality and efficiency of training. These methods enable students to actively participate in the learning process, understand and apply knowledge in practice, and develop important life skills such as critical thinking, problem solving, and collaboration.

The teaching and learning of a highly specialized course in interferometry can be significantly enhanced through innovative gaming methods. Below, we discuss the application of gaming techniques in the educational process and their impact on the effectiveness of students' education [11]–[15].

6.1. Implementation of gaming methods in the educational process

Gaming methods include the use of gamified tasks, simulation games, and interactive exercises aimed at visualizing interference phenomena and measurement processes through interferometry. These methods allow students to understand better the principles of equipment operation and data analysis by giving them the opportunity to virtually experiment with various settings and scenarios while interferometer usage.

6.2. Advantages of gaming methods in interferometry study

Gaming methods make a significant contribution for improving the student motivation and activity by providing a more dynamic and exciting learning environment. They also help to overcome psychological barriers associated with the complexity of the subject and promote better memory and understanding of the material through active engagement in the learning process.

6.3. Development of a mobile application based on gaming principles

The developed application integrates gaming elements with the basics of interferometry, offering to solve a row of tasks and challenges that simulate research and engineering problems. The application can be used as an independent learning tool or/and as a supplement to lectures and laboratory works.

6.4. Addressing potential issues and limitations

Despite existing challenges such as the complexity of terminology and the need for continuous content updating of the application to maintain relevance, gaming methods are inherent in a great potential. To overcome these difficulties, the ongoing research and improvement are necessary, which would include feedback from students for adaption of the educational material to their needs.

6.5. Prospects for future research

Further research aims to develop and test new gaming strategies that would more accurately reproduce the conditions and challenges for students facing in the real world of interferometric measurements and ensuring the better assimilation of professional skills.

7. Conclusion

The game-based learning methods in the study of interferometry turned out to be quite effective, enabling students to better understand and feel the learning material. The mobile application, developed on the basis of game principles, not only simplifies the learning process, but also makes it more exciting and interactive [16]. Despite some disadvantages, such as the difficulty of understanding the terminology and the limited number of users, this methodological approach opens new horizons for the education and research. Game visualization, dynamic tests and interactive tasks become a bridge between theory and practice, allowing you to dive deeper into the world of measurements.

The integration of modern educational technologies into the process of studying important scientific areas can serve as the key to increasing the effectiveness of education, stimulating interest and developing scientific thought, and mobile applications can become indispensable in the study of other complex disciplines, opening the door to new teaching methodologies and research approaches.

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Вивчення інтерферометричного обладнання через інтеграцію ігрових методів у мобільний застосунок

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Анотація

Стаття присвячена вивченню та розробці мобільного застосунку для базового та поглибленого вивчення інтерферометричного обладнання. Основуючись на сучасних підходах до освіти та актуальних потребах студентів, досліджено особливості роботи з високоточним інтерферометричним обладнанням. В статті розглядаються проблеми, пов'язані з вивченням інтерферометрії як дисципліни: складність розуміння термінології, унікальність прикладної бази та обмежена кількість студентів. Для вирішення цих проблем пропонується залучення ігрових методів навчання, що дозволяє зробити процес більш занурюючим та ефективним. Застосунок, розроблений на базі платформи Unity, має на меті зробити вивчення доступним, цікавим та ефективним, комбінуючи теоретичні знання з практичними завданнями та ігровими елементами.

Ключові слова: інтерферометрія; мобільний застосунок; освітній інструмент; ігрові методи; високоточне обладнання.