GAME-BASED INTERACTIVE SOFTWARE FOR MECHANICAL LABORATORY

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Summary The paper presents the interactive game-based software «InMechLab» for mechanical laboratory developed at Southern Federal University. It have been applied there to create content-rich and exciting environment during laboratory exercises, as the action of the game takes place in an ordinary educational mechanical lab, where the user has to play the role of careless student. The content of the game is designed to help students and lecturers, as it includes not only detailed theoretical background on the subject of experiment, but also the tests and visual experiment simulations, in which users can check their knowledge before conducting a real experiment.

INTRODUCTION

In recent years, there has been a growing interest at universities and research institutes in the development and application of the innovate teaching techniques. In the new global computerized society, pedagogical techniques using interactive information technologies and systems have become one of the key issues in educational domain. One of the most surprising success in this field was connected with interactive «serious games» – the accepted term for games with an educational intent. They need to be engaging, although not necessarily fun, while the learning can be implicit or explicit. These games have proved their efficiency since they were successfully used in military train operations [5], in health sector as strategy for medical practitioners preparation [6], in business [2], commerce and other spheres, where it is possible to simulate different realistic situations for upgrading professional skills of the workforce, enhancing their competitive advantages, while increasing their morale. As an educational tool serious games have been applied not long ago, but intensely – they are already integrated into teaching process in a number of schools [3], colleges, universities and even research institutes. Gaming component in such educational processes has allowed enhancing and supporting learning, making the process of study fascinating. Traditional laboratory exercises designed to give students a better understanding of theoretical concepts are often platforms for the implementation of such serious games with a research basis. In the field of mechanics carrying out of experiments plays a key role in the learning process. However, necessary laboratory equipment is not always available and students do not have free access to it since numerous experiments are too expensive and not so beneficial. To this end, a plenty of educational institutes over the world has recently started to develop interactive systems that facilitate the process of preparation for real experiments or replace them [1, 4].

This paper will review the research conducted on the development of gaming software for the computer-based support of the laboratory exercises in the study of some aspects of such fundamental science as mechanics.

MAIN CONCEPTS

The present study was undertaken in order to describe the process of the development of the interactive educational complex «InMechLab».

The structured program for students specialized in mechanics at Southern Federal University focuses on theoretical mechanics, engineering mechanics, continuum mechanics, elasticity and plasticity theory, hydromechanics, fracture mechanics and so on. At the center of study process experiments, practical and laboratory investigations giving students the ability to measure, describe and model the physical world of materials and mechanisms are situated. During such exercises students have a chance to apply knowledge of fundamental principles, obtain essential skills and scientific tools to be able to predict and understand mechanical phenomena. According to the established practice, students are divided into small groups of 3 - 5 persons to take part in laboratory experiments. The students of every group hash out necessary materials together (theoretical background, methods, order of operations in experiments) and then carry out an experiment. In order to enhance the preparation quality of students during their independent work before carrying out experiments, the team of postgraduate students and researchers at the department has started to develop the game-based interactive software «InMechLab», where a user can feel himself immersed in a real lab with available information on the main theoretical concepts and experimental methods. This software is designed to help students and lecturers, as it includes not only detailed theoretical statements on the subject of experiment, but also the test and visual experiments, in which users can test their knowledge before conducting the actual experiment. This interactive complex is already implemented and actively used at the department.

Our experience tells that a participation in the real experiment and even successful completion of it does not mean successful acquirement of the knowledge minimum which is assumed to be obligatory. So, another purpose of «InMechLab» software is to induce the students to apply all knowledge required and, in that way, to ensure their acquirement. Additionally, work with unavailable equipment can be replaced by virtual demonstrations, so the lack of knowledge can be avoided.

The work of the «InMechLab» software can be illustrated briefly by the example of the virtual experiment «Brinell

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hardness». The action takes place in an ordinary educational mechanical laboratory, where the user has to play the role of careless student (Figure 1). To pass experiment three stages must be completed: learning of the theoretical background, confirmation of the knowledge obtained (in the form of the test) and the direct conducting of virtual experiment. From the comprehensive manual section the student can obtain general information about how to measure the resistance of a material to plastic penetration of its surface, find hardness number of a material with variety of methods, assess the quality of construction material and identify the causes of durability loss. Special attention is given to the classification of methods of hardness testing, detailed description of the most common static indentation tests (Rockwell, Brinell, Knoop, Vickers) are presented. The manual also introduces to students the indenters used to determine the hardness and equipment proposed for most tests.

After getting acquainted with these reference materials a user proceeds through the knowledge test. Answering the most questions, he can proceed to the visual interactive experiment (Figure 2) that demonstrates the behavior of the press during the Brinell test. In the Brinell hardness test, a hard steel sphere, usually 10 mm in diameter, is forced into the surface of the material. The diameter of the impression left on the surface is measured and the Brinell hardness number (BHN) is calculated. Users have the opportunity to make measurements of the hole, the necessary characteristics to calculate and enter the results for further validation. Thus, a student familiar with the program, passed all its stages and, finally, received the virtual set-off can confidently proceed to real experiment.

Figure 1. «InMechLab» software: main form.

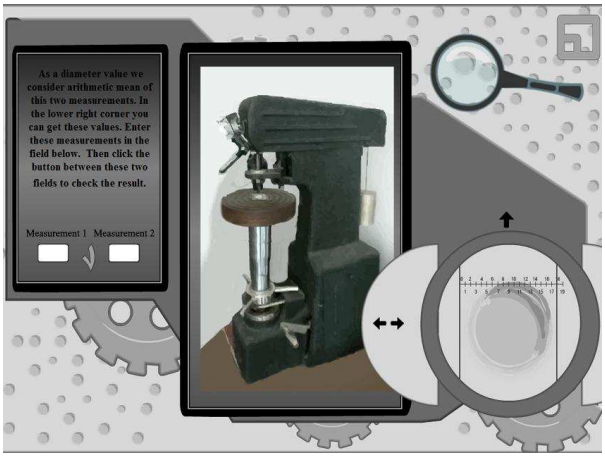

Figure 2. «InMechLab» software: experiment.

It should be noted that in the development of this interactive serious game not only lecturers but also students were involved, that lead to gradual enhancement and update of the software throughout the learning process. Close collaboration among members of this research team in technical and creative as well as pedagogical aspects makes the work on «InMechLab» exciting and entertaining.

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