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Development of VR educational instruments for school pre-professional education in a research university

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Abstract

The area of computer science puts a lot of effort into the development of virtual reality technologies (VR technologies), especially in pre-professional education – school etc. Technologies of VR opens a lot of new opportunities in training and education, it is widely used in education establishment, especially in computer sciences and mechatronics and robotics education in Russian schools and universities. VR technologies helps to save time, money and other resources in contrast to the traditional approach of teaching. At the National Research Nuclear University MEPhI we have an extensive experience of application of high technology in education. In this article we present the results of our practical research of development of VR educational instruments for school pre-professional education. The specificity of our research is that we have developed an educational program for the acquisition of skills in working with VR technologies in accordance with CDIO standards.

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Keywords: Computer science; VR; preprofessional education

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1. Introduction

Progress in the area of computer science is also based on the introduction of cyber-physical systems in mass industry [1-5]. It is important to interest students in cyber-physical systems.

At the National Research Nuclear University MEPhI, such cyber-physical systems occupy a dominant position in research, development and education, because VR technology is a fast-growing technological area of science [6-10]. Our program allows students to prepare not only the theoretical component of training, but also practical skills. Therefore, having received a theoretical basis, the student has the opportunity to immediately apply and work out these skills in practice within the course. As a result of the developed program, a highly qualified specialist will be able to create a competitive product [6-9]. Moreover, the educational programs are developed in accordance with international CDIO standards [10-12].

CDIO standards help to control the ratio of the content and effectiveness of educational programs to the level of development of modern technologies and the expectations of employees. There are 12 standards, which define the special requirements of CDIO programs:

- The concept of engineering educational programs (Standard 1)
- The formation of curriculum (Standards 2, 3)
- The practice-oriented educational environment (Standards 4, 5, 6)
- The educational methods and qualification of teachers (Standards 7, 8, 9,10)
- The methods to evaluate the students' training results and the program in whole (Standards 11 and 12)

2. Development of VR educational instruments for school pre-professional education on the example of a practical program of a research university

Currently, the implementation and development of software for students and pre-professional education is developing rapidly. To carry out developments in this area, it is necessary to build a hierarchical structure of possibilities and steps for building software (program) products of this kind. This program has technical focus.

Program level - basic.

The program aims to interest students in studying engineering, introduce them to virtual reality technology, and teach them the basics of developing new technical systems.

Program tasks:

Training materials:

- to give a set of knowledge of the basics of designing complex technical systems
- give knowledge of the basics of working in various CAD systems
- provide knowledge of the basics of working in the Unreal Engine
- teach them correctly use the existing database 3D models, translate them to other formats, and change them
- teach them work well with virtual reality controllers and glasses
- teach them correctly prepare a virtual room and workplace for various tasks

Educational programs:

- develop children's logical thinking skills
- create constructive content thinking skills
- develop cognitive and creative skills
- promote initial career guidance students

Nurture programs:

- generate it self-discipline, responsibility for your job
- raise your rating communication skills qualities that ensure successful work in the company the team

Forms and mode of classes:

Form of classes:

- the program provides for a group card the form classes, as at students can have different projects within the same field of activity

Class mode:

- classes are held once a week for 2 academic hours. During classes, there are mandatory breaks of 15 minutes at the end of each hour
- classes are held in the laboratories of the Department using standard equipment

Planned results:

By the end of the training, students will know:

- features technology applications VR
- features of working in various CAD systems
- features of working in the Unreal Engine

Also, they will be able to:

- use different databases 3D models
- properly prepare models for further work with them
- correctly operate various equipment

3. Certification forms and evaluation materials

For each year of study, the main parameters are highlighted. In accordance with these parameters, students' knowledge and skills are evaluated according to the specified criteria.

Table 1. Parameters of assessment of the student's knowledge and skills

Evaluation criteria			
Estimated parameters	Minimum level of knowledge and skills	Acceptable level of knowledge and skills	Optimal level of knowledge and skills
	1 point	2 points	3 points
Safety knowledge	Uncertainly formulates TB rules when setting up a virtual reality kit	Knows the rules of TB when setting up virtual reality kits, and can apply them in practice	Knows the rules of TB very well when setting up virtual reality kits, and can put them into practice and help friends
Knowledge of the specifics of working in various software environments	Does not know exactly how to work in the programs used	Knows exactly how to work in the programs	Knows exactly how to work in the programs, and can help friends
Practical skills			
Ability to prepare a model for visualization and import it into Unreal Engine	Doesn't know how to work with the model and import it	Can work with the model and import it under the manual teacher or senior colleagues	Can prepare and import the model itself

Certification of students is carried out in accordance with the Regulations on certification of students in study groups and groups based on the results of the implementation of educational programs with the issuance of certificates.

Table 2. Educational and thematic plan

Section name (topics)	Number of hours			Forms of certification (control) by sections
	Total	Theoretical	Practical	
Introductory lesson. Instructing on technical equipment safety	2	1	1	Survey results
Practice techniques for working with models of different formats	60	2	22	Analysis achievements

Preparation and setting up virtual reality equipment	12	2	3	Analysis achievements
Importing models to the Unreal Engine environment	12	2	7	Analysis achievements
Visualization of models	30	2	21	Analysis achievements
Final lesson	1	1	-	Analysis achievements
TOTAL:	64	10	54	

4. Program content

Section 1. Introductory lesson safety Briefing. Familiarization with the subject of classes. Safety instructions, rules of behaviour on the site when working with equipment. Practical part: subject introduction to various samples 3D models. Trial work with VR.

Section 2. Practice working with ready-made virtual models of various formats. Basics of working in various CAD systems. CAD selection criteria for various model changes. Learn how to import models into other software environments. Practical part: upgrading existing 3D models.

Section 3. Developing your own virtual models. Features of creating new 3D models in various CAD systems. basic general knowledge of ESKD. Practical part: creating your own 3D models. Use them together with ready-made third-party models to create assemblies.

Section 4. Importing models to the Unreal Engine environment. Technology for importing models and assemblies to the Unreal Engine environment. Practical part: working with models in Unreal Engine, changing their scale and orientation in the virtual world.

Section 5. Visualization. Technologies for creating animations and implementing object behaviour physics in a virtual environment. Practical part: creating patterns of behaviour of third-party objects in a virtual environment, building ways to interact with them using controllers, as well as the task of virtual logic.

Section 6. Final lesson. Certification of students.

5. Organizational and pedagogical conditions for the implementation of the program. Educational and methodological support of the program

Much attention is paid to engineering topics from the very beginning of training. Even if the student has not yet created their own virtual model, they can practice their skills in working with models on existing samples. When conducting classes, the teacher uses the following methods of work:

1. Verbal method. Historical background of history on the topic. Explanation of the execution sequence operations.
2. Demo account method. Teacher performs an operation in front of the student, showing the technology and sequence of operations by its own example.

The teacher explains children to introspect the work done, the acquired skills and summarize the results of the classes held. Together with the teacher students work on mistakes. The conditions of classes in the group provide for an atmosphere of psychological comfort, i.e. the teacher's kind attention to all children without exception, taking into account the observance of the necessary level of discipline. Educational literature and video tutorials on the subject of classes are used as didactic materials [18-22].

In addition, we use samples of virtual models presented in the laboratory database (created parts and assemblies created at the Department for training and practical purposes). We also use specialized literature, photos and videos on the history of the development of virtual reality technologies, and engineering specialties.

6. Conclusion

In accordance of CDIO standards our team has developed a practical program of VR technologies for pre-professional school education. Higher we describe content, aims and some other features of this program. the program includes 6 components, each of which contains both a theoretical and a practical part. Much attention is paid to teaching methods. The material is delivered to students by the verbal method and the method of demonstration.

In addition, we note the importance of a favorable environment in study groups, since this directly affects the level of interest of the student in the subject and his degree of knowledge gained. Also, in the course of training, students are provided with a lot of didactic materials, additional literature, photos and videos. Our program helps students to acquire theoretical and practical skills of working with VR technologies.

Students have the opportunity to immediately hone their theoretical skills in practice. As a result of passing the basic course, the student develops a high-quality knowledge and skills base and warms up further interest in virtual reality technologies.

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