

Chapter 8

The Project Title: The Virtual Laboratory and Quality of Education



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8.1 Introduction

The need in using innovative methods in learning professional technical subjects in the educational institutions defines the up-to-dateness of this theme.

In spite of the sufficient provision of the educational institutions with the technical media of teaching, often teachers cannot give students the full complex of the knowledge, which is required in the modern era.

The electronic educational resources based on the modern computer three-dimensional simulation of physical processes and phenomena are being realized in the form of multimedia teaching and research laboratories or virtual simulators. The argument for using new technologies of virtual simulators is an active introduction of the modern means of computer simulation and information technologies in the sphere of education, as a new transdisciplinary area.

The main reasons for using the technologies of virtual simulators are as follows:

- The existing laboratory stands and workshops are not sufficiently equipped with modern appliances, devices, and tools.
- The majority of the laboratory stands and training workshops are put into effect after their withdrawal from the production, do not meet the modern requirements and outdated, and thus can distort the results of the experiments and serve as a potential source of danger to the students.

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- The laboratory work and stands require annual upgrading, which leads to additional financial cost.
- The areas like construction material engineering or physical chemistry, in addition to the equipment, need consumable materials, raw materials, reagents, etc., the cost of which is sufficiently high.
- The modern computer technologies allow to see the processes, which are difficult to see in the real world without the use of additional equipment, for example, due to the small size of the observed particles.
- The virtual simulators allow to simulate the processes that are fundamentally impossible in the laboratory conditions.
- Safety is an important advantage for using virtual laboratories in the cases of working with high voltages or chemicals.
- Due to the inertia of the work or processes, it is difficult to carry out repeated analysis or verifications in some laboratory equipment during the allotted time.

Considering the abovementioned facts, it is necessary to introduce a new, effective, and affordable teaching methodology, which would facilitate the solution of the following tasks:

- Initiate sufficient interest among the audience, thus will increase activity and independence of their educational work.
- Attract the attention of listeners, considering their psychological peculiarities, to improve the perception of educational material due to its multimedia character.
- Provide full control on learning of the material by each student.
- Facilitate the process of repetition and training in preparing for exams and other forms of knowledge evaluation.
- Release teachers from the routine monitoring and counseling activities.
- Use extracurricular time to study the design in the form of home assignments.

Exactly from this point of view, the introduction of information technologies promotes optimal solution of the above problems and elimination of the number of shortcomings of the traditional method of teaching. The multimedia teaching and research laboratories, which are created on the computers, can help in solving these issues fully.

8.2 Practical Application

The amount of hours allocated for teaching of chemistry in the higher educational institutions of the Republic of Tajikistan is not sufficient to capture all the themes of the chemistry lessons. The multimedia means are regularly used in the lessons as innovation methods for accelerated education of students.

To this end, the Branch Office of the Tajik Technological University in the city of Isfara uses multimedia technology as a modern method of teaching in all subjects and especially in chemistry.

While teaching chemistry, it is efficient to use computer technologies in the classroom for teaching new materials (presentations for lectures), developing skills (educational testing), as well as carrying out practical works in chemistry.

The purpose of the computer application in a chemistry class is to create didactic active environment conducive to productive cognitive activity in the process of learning new material and developing students' thinking.

By implementing new technologies in the educational process, we give students the opportunity not only to learn the subject but also to operate a computer. Many tasks in the computer variant of the subject allow developing the creative abilities of students, looking at the subject from the other angle and expressing themselves in new activities. A definite positive side of introducing new technologies allows us to make a new step toward the future, where the computer is a means for realizing our capabilities and talents (Paluch 2015).

When working with the multimedia technology, the students are actively involved in the cognitive activity from the beginning. During such training, they learn not only to acquire and to apply the knowledge but also to find the necessary learning tools and sources of information and to be able to work with this information.

8.3 Use of Virtual Laboratories in the Chemistry Lessons

The objectives for use of virtual laboratories in the lessons:

- Create a bank of training modules that can be used in the lessons.
- Implement the idea of individualization of learning in accordance with the speed, which is the most appropriate to each student.
- Optimize the monitoring process to check students' knowledge.
- Minimize the likelihood of the formation of students "inferiority complex".
- Improve the quality of education.

The extensive use of the animation and chemical modeling by using computer makes the teaching and learning process visual, understandable, and remembering. Not only the teacher can check the students' knowledge by using the test system, but also the student himself/herself can control the degree of grasping the material. The use of virtual tours greatly expands the students' horizons and facilitates the understanding of the essence of chemical production. We believe that the main advantage of the computer design in the chemistry class is its use when considering explosion and fire processes, reactions involving toxic substances and radioactive substances, in short, everything that makes a direct danger for the health of students.

8.3.1 An Interactive Whiteboard as a Mean for Productive Learning of the Educational Material in the Chemistry Classes

An interactive whiteboard is a touch-sensitive screen connected to a computer, which transmits the image from the projector to the board. It is enough to touch the surface of the board and to operate it.

No doubt that an integral part of the chemistry is an experiment. In the traditional lessons, students do practical work, the purpose of which is to examine the properties of the substances with the help of observations. When conducting experiments, the students observe only the external effect of interaction and express the changes occurred with the substances in the form of equations, by using chemical formulas and mathematical symbols. Why do some chemical reactions occur and others do not? What happens to the atoms and molecules in the process of chemical reactions? To see this, one needs to look into a completely different world – a microworld, which is really closed. Not everyone has the ability to abstraction. So, in parallel with the demonstrations of experiments, we have decided to show with the help of graphics, animation, and sound effects, using electronic presentations and work on the interactive whiteboard how this world of atoms is arranged and what happens to the atoms and molecules in chemical reactions (Balanova 2013).

An interactive whiteboard use is the matter of topical interest. The lessons conducted with the help of an interactive whiteboard are more productive compared to the traditional lessons. It is known that 87% of the information comes into the brain through the visual channel of perception (Norenkov and Zimin 2004). The use of a computer and interactive board opens up great opportunities: the brilliance and different effect of entry, movement, and exit of objects. With the help of graphics and animation, one can show how gradually a structural formula of the substance appears and how consistently transfer of complex reactions happens; it can display the mechanism of chemical reactions – in which chemical bonds are broken and are formed again – and at the same time how reactive molecules are aligned with each other; it is possible to show how the speed of the reaction takes place.

Thus, an interactive whiteboard gives much greater opportunities for joint activities of the teacher and students compared to the traditional board:

- A lesson with an interactive whiteboard is better provided with the use of visual methods and information, contributes to the increase of interest and attention in the class, and gives the opportunity to save study time, to check homework quickly and effectively, and to deepen the knowledge in the study of the chemical reactions by designing molecules on the interactive whiteboard and improving the knowledge on the types of chemical bonds.
- At such type of lesson, you can return back to the previously received information.
- The modern interactive whiteboard creates a special spirit of cooperation in the classroom. An interactive whiteboard is nice.

There are “teacher–computer”, “student–computer”, and “teacher–student” interactions. Conducting lessons with the interactive whiteboard broadens the horizons of interaction: it provides the broad possibility for combining “teacher–computer–student” interaction. The lessons using ICT arouse a desire of the students to make presentations themselves and to show them to the classmates (Ivanov 2009, pp. 207–211). No reports and messages can withstand the presentations on the interactive whiteboard.

8.4 Conclusion

Thus, the effective application of virtual laboratories in education contributes both to the improvement of the quality of education and saving of the financial resources, as well as creating the safe and clean environment.

Considering the above facts, it arises a need in introducing a new, effective, and affordable method of training – interactive learning by using virtual laboratories and interactive board.

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