Application of Interactive Devices and Virtual Lab in Chemistry Learning

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Abstract
This paper presents an educational project (“Introducing Interactive Teaching Methods in Inorganic Chemistry and Investigation the Effect on the Quality of Knowledge”) of blended learning in the studies of “Food Technology” in Technical College of Yambol. The blended learning model is established and supported by e-learning on-line materials. The multimedia courses, lessons and e-quizzes have been created. Moodle platform is used for the management of on-line educational process. We propose the innovative devices that can be apply in Chemistry lessons and by integrated audio – video tools, specific programs and interactive whiteboards, virtual labs to create simulations of chemistry experiments and solving different problems.

Keywords: blended learning, high education, e-learning environment, whiteboards, Virtual Chemistry Lab

1. Introduction
Last years blended learning is widespread in universities and other similar higher educational institutions (Dziuban et al., 2004; Macdonald, 2006; Ticheler, 2009; Donoso et al., 2010). New learning and teaching models that take advance of the new online environments and personal computers are emergent. Innovative pedagogical models appear that change the emphasis from teaching-centered to student-centered in learning paradigms and new theories of learning (social constructivism and brain-based learning).

The social constructivist theory of learning, which originated with Vygotsky (1962), claims that learning centres on social interaction and shared tasks in which individuals build their learning by interacting with the environment, particularly teachers and fellow students (Beetham, 2002). A number of authors point out that interactive, collaborative learners can be well-supported in a web-based environment and remark that asynchronous online communication encourages significant peer interaction to take place (Roberts, 1995; McMahon, 1997; Oliver, 2001).

Several authors have discussed the use of VLEs in higher Chemistry education (Chin, 2003; Charlesworth & Vician, 2003; McDonnell & O’Connor, 2005; Brouwer & McDonnell, 2009; Donoso et al., 2010). Chin (2003) has produced guidelines for using VLEs. Charlesworth and Vician (2003) described their introduction of a Web CT VLE to attempt to improve motivation and learning on a first year chemistry programme.

Examples of innovative approaches that use educational technology to support active learning in chemistry lectures, tutorials and laboratory sessions are considered.

2. Materials and methods
This paper presents an educational project of blended learning suitable for the subject General and Inorganic Chemistry in the studies of “Food Technology” in Technical College of Yambol. The blended learning model is established and supported by e-learning on-line materials that included
different courses. Moodle platform is used for the management of on-line educational process. This year start a project “Introducing Interactive Teaching Methods in Inorganic Chemistry and Investigation the Effect on the Quality of Knowledge”. The project seeks to build up an innovative style of teaching Chemistry upon the good practices of face-to-face teaching methodologies and resources of fully ICT-learning environment.

In Technical College of Yambol study of General and Inorganic Chemistry is included as compulsory discipline. Each week students have lectures (3 academic hours), laboratory exercises (2 academic hours) and stochiometry resolving problems in seminar lessons (2 academic hours). With the new project work, the didactic materials has been created on the field of General and Inorganic Chemistry (http://tk.uni-sz.bg/edutk): virtual library with – lectures; exercises; multimedia sources; movies; presentations; tests; glossaries; links to other web-base on-line resources etc.

1. Challenges of teach and study Chemistry
Chemistry is challenging to learners because a chemist needs to think on several levels: The observational level (macro level), the molecular level (sub-micro level) and the symbolic and process level (Johnstone, 1982). This can lead to misconceptions which are often very difficult to overcome and can even prevent any further learning.

In cognitive psychology, there is one memory system, but it is normally divided into three functions for storage (Anderson, 2000): sensory, short-term (often called working), and long-term (often called permanent). The sensory memory retains an exact copy of what is seen or heard (visual and auditory). It only lasts for a few seconds; while some theorize it last only 300 milliseconds. It has unlimited capacity. Short-Term Memory (STM) – the selective attention determines what information moves from sensory memory to short-term memory. STM is most often stored as sounds, especially in recalling words, but may be stored as images. It works basically the same as a computer’s RAM (Random Access Memory) in that it provides a working space for short computations and then transfers it to other parts of the memory system or discards it. It is thought to be about seven bits in length, that is, we normally remember seven items. STM is vulnerable to interruption or interference. Long-Term Memory - is relatively permanent storage. Information is stored on the basis of meaning and importance (figure 1).

To design lessons that affect deeper roots of retention there is a need in the understanding of the Information Processing Model (figure 1) and how learning occurs when information is transferred from sensory memory to short-term memory into long-term memory. This understanding of the process of learning helps lesson designers’ impact higher retention rates among learners. Long – term memory or retention of information can be affected through lesson design (King, 2011).

![Figure 1 Information Processing Model (Three Box Model): Three Interacting Memory Systems](http://cla.calpoly.edu/~cslem/101/7-C.html#Sensory Memory intro)
3.1 Virtual Chemistry Lab

The purpose of this program is to create a virtual chemistry laboratory to help students who study chemistry for the first year and for their teachers. The on-line recourse of the Virtual Chemistry Lab is [http://chemistry.dortikum.net/bg/news/](http://chemistry.dortikum.net/bg/news/) in Bulgarian language and [http://chemistry.dortikum.net/en/news/](http://chemistry.dortikum.net/en/news/) in English. It has an easy-to-use interface, a help file, a manual and is completely free.

Using this program, students acquire basic skills and knowledge for work in a laboratory without the risk of incidents in a real laboratory. Users have the option to check their skills and knowledge in an unconventional and entertaining way. As far as its further development is concerned, the program has the option for updating its database of the elements and their compounds. The program can also be updated over the Internet, which helps to constantly keep its database up-to-date. What’s more, teachers can manually add more substances and reactions and thus enrich the students’ experience.

Virtual Laboratory of Chemistry has (Figure 2):

- a way to visually conduct experiments with different substances, a model- and analysis-oriented view of the current reaction;
- an “assistant” to simplify the work with the program, valuable encyclopedic information regarding the elements;
- a glossary;
- self-test facilities;
- interactive lab exercises;
- a sophisticated unit converter;
- a lab log;
- a built-in calculator;
- an equation editor;
- a help file;
- an attractive interface and many other features.

![Figure 2 Virtual Chemistry Lab](image)

A chemistry project without the periodic table of elements is nothing. There are two variants of the table – normal and unfolded (figure 2). They differ in nothing except the location of the
elements. To satisfy the students’ curiosity, there are included information about every element – physical attributes, history, interesting facts, a photo of the element and others. Apart from the periodic table of the elements, there are also several other reference tools included – the solubility table, Oxidizing and Relative activity of some of the substances.

When students first encounter with the chemical terminology, they find it hard to remember it without constantly using it. This will no longer be a problem as the program has a built-in glossary of the most widely used terminology. It’s a wonderful way to recollect the meaning of any unknown term at any time.

The most interesting thing for some of the students and most of the teachers is the self-test feature of the program. There are several tests – the first is the standard one – several answers and only one of them is the right one. After the test is completed, a mark is generated depending on the number of the right answers. This is a good way for teachers to check students’ knowledge. The questions in the test can be modified in the administrative panel. Another tool of examination is the equation editor. It can help the teacher to check the students’ skills of solving chemical equations. The last but not least important method for examination is using simple lab experiments. A reaction is visualized onscreen and the student is asked a question regarding the reaction. Seeing the changes on the screen, the student has to consider what he sees and answer correctly.

The students learn about some of the most widely-spread elements, compounds and reactions, they also learn how to solve equations and different problems like the mass and so on. In this case they need to use different units and convert them. The program incorporates an extremely useful unit converter and it can convert all kinds of units. Another useful tool is the calculator which helps the students to calculate any sum they encounter with.

3.2 Web-based resources

With the new project work, the didactic materials have been created on the field of General and Inorganic Chemistry and publish as on-line resources at http://tk.uni-sz.bg/edutk. It included: virtual library with – lectures; exercises; multimedia sources; movies; presentations; tests; glossaries; links to other web-base on-line resources etc.

The Computer Assisted Learning stimulates the visual hearing memory and transposes the students in the middle of physical phenomena. The realism of dynamical pictures, the video joined with the sound and the motion, the possibility to recreate the physical reality with digital technique make the didactics movies the most important teaching tools (Bostan & Antohe 2009). On the web-site of General and Inorganic Chemistry movies from chemistry history and lab experiments are linked and available as on-line resource.

Provision of a range of online learning materials, activities and self-tests with instant feedback allows learners to determine how well they understand and can apply material introduced in their lectures (Adams, Byers, Cole & Ruddick, 2003; O’Connor & McDonnell, 2005). Online self-study quizzes with instant and detailed feedback are very useful, allowing first year students at Dublin Institute of Technology, Ireland, to determine how well they understand and can apply the topics they are being taught (O’Connor & McDonnell, 2005). This type of support has been found very useful for teaching chemistry to large groups of first year undergraduates, particularly those who have not studied chemistry at secondary level (Brouwer & McDonnell, 2009).

3.3 Interactive Whiteboard

The interactive devices give opportunities for the lecturers in the universities for better visualization of the learning contents (figure 2, 3, 4). The visualization of the educational material gives a better possibility of perception of the educational contents and more time for discussions. This kind of innovative education increases attendance and engage the students in more active and
deeper learning of the educational material. It is undoubted fact that the visual memory is many time powerful and it allows a man easier and quicker learns the material.

Visualization of chemical structures and reactions on a molecular level is introduced to develop a deeper understanding of chemistry in learners. Computer animations, simulations and 3-D molecular modelling can be used to improve learning and understanding of chemistry, not only by students at the beginning of their study, but throughout (figure 3).

Interactive whiteboards allow teachers to record their instruction and publish on-line the material for review by students at a later time. This can be a very effective for students who benefit from repetition, who need to see the material presented again, for students who are absent from school, for struggling learners, and for review for examinations (figure 4).

A good explanation by the lecturer is not enough to achieve deep learning by students. The learners need to be actively involved (Stanley & Porter, 2002). With the implementation of interactive whiteboard that goals easy can be achieved. The main ways of use interactive whiteboards in the study process are: save lessons to present to students who were absent; create video files and posted to the server or web; present presentations created by student or teacher; digital storytelling; brainstorming; take notes directly into PowerPoint presentations; video movies; reinforce skills by using on-line interactive web sites; diagramming activities; teaching steps of solving the problems, etc. (figure 4).
During a lecture, incorporation of online methods can be achieved by using simulations, animations and computer-generated molecular models to demonstrate and explain difficult concepts. All these methods are easy implementing using IWBs. Group discussions, an exchange of opinion with a neighboring student as well as asking questions, solving on-line quizzes in class through IWBs, are common methods employed to make lectures active and interactive.

4 Conclusion
It has been recently proposed that the best practices for teaching chemistry designed and developed must be shared. Teachers explaining chemistry education techniques and current technologies (an associated DVD and website) would be used to ensure effective and timely dissemination (Greenbowe, 2008).

Working on projects and share the information about innovative devices and their implementation in the teaching and learning process is beneficial, worth it and have to be encouraged.

References
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