VlabEmbed – the New Plugin Moodle for the Chemistry Education

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Abstract. *Research goals:* The necessity of developing a plugin for Moodle, which is used to support the activities of experimental chemistry are substantiated. Description of created VlabEmbed plugin and the process of installing and configuring VlabEmbed plugin in system Moodle are reviewed. *Object of research:* Moodle plugins for chemistry education. *Subject of research:* VlabEmbed – the new plugin Moodle for the chemistry education. *Research methods:* review and analysis of scientific publications and Moodle plugins for the chemistry education. *Results of the research:* VlabEmbed plugin in system Moodle are created.

Keywords: Moodle, Tools of teaching chemistry, Virtual laboratory, VlabEmbed plugin.

Key Terms: Key Terms**.** Methodology, InformationCommunicationTechnology, ICTTool

1 Introduction

1.1 The Problem Statement

Moodle is an open learning platform, which aims to create a personalized learning environment for the user. The infinite variety of user interests is the "engine" for the development and improvement of the Moodle.

There are many chemistry courses are implemented in Moodle. Proper construction of the chemistry course is impossible without taking into account specifics of chemistry science. So the main tool of teaching chemistry is a chemical experiment.

1.2 The State of the Art

Moodle has enough tools to visualize the other chemistry features – the chemical language (formulas, special symbols and notation forms) and the models of microcosm objects (atoms, molecules, crystal lattices). Some popular chemistry plugins and modules: Chemistry editor, EasyChem Chemical Structure and Equation Editor, Chemical Structures and Reactions Editor (for writing chemical formulas and equations); Jmol (for embedding 3D-models of the molecules in the learning modules); EasyOChem (set of plugins for creation of test tasks in organic chemistry with chemical formulas and equations usage).

But ensuring the possibility of chemical experiments (even a simulation) in the Moodle there was a gap. To carry out virtual laboratory experiments in chemistry there is a sufficient amount of software, the most famous of which is Model Science ChemLab and ChemCollective Virtual Lab (VLab). ChemLab is a proprietary software which runs only on the local computer. VLab is non-commercial software, available both online and offline. VLab allows to perform virtual laboratory works on chemistry (mainly analytical and physical chemistry). The program has multilingual interface (German, Spanish, French, Greek, Portuguese, Russian, Ukrainian etc.) with a large repository of chemistry problems.

1.3 The Purpose of the Article

Our *main purpose* was to create a plugin that brings the VLab functionality into Moodle and allows to download and install the VLab files to the site with Moodle training courses.

2 Presenting the Main Material

2.1 The Technological Aspect of Use

New plugin VlabEmbed is a filter that allows to embed the VLab problems into the Moodle courses pages using an applet vlab.jar. For correct operation of the applet, you will need to install Java Plugin.

VLab also requires several data files for the operation, mostly with the extension .xml. One of these files contains links to all the other files and is considered as a main file. The essence of the VlabEmbed filter is to replace the links to the according main XML file on the applet call, which runs virtual laboratory. For this purpose the link to the main XML file of virtual lab or any other text with a hyperlink to this file should be inserted into the block of the tags [vlab] ... [/vlab].

To install and run the filter, you need to follow the next steps:

1. Download the archive with the plugin to the computer by the link https://moodle.org/plugins/view/filter_vlabembed.
2. Log in to Moodle as an administrator, go to the Site Administration | Plugins | Installation of plugins.

3. In the installer of modules Select the file ... with downloaded plugin archive and click the Install the module from ZIP package.
4. Select the Site Administration | Plugins | Filters | Filters management.
5. Select On or Off in the drop-down menu, against "VlabEmbed".
6. Set the plugin parameters convenient for you: the width and height of the applet window and the language (Brazilian Portuguese, Catala, German, Spanish, French, Greek, Russian, Ukrainian) drop-down menu.
7. Because of the discrepancies in licensing the applet files that are required for the virtual laboratory, are not included into VlabEmbed filter package. But they can be downloaded from an external source using the built-in downloader by choosing the link Try to get a minimal set of Virtual Lab applet files from ChemCollective site.

You can also specify some paths (an external links), which will be used for the uploading of VLab files in the editing window: http://ict-chem.ccjournals.eu/vlab_ukr.zip, http://kdpu.edu.ua/download/kaf_chem/books/vlab_ukr.zip or https://sites.google.com/site/kafedrahimiie/necipurenko-p/chemistry-virtual-lab-ukrainian-version/ukraienskaversiavirtuallab/vlab_ukr.zip. If none of these links will be correct, plugin attempts to upload a minimal set of files from the ChemCollective site. If this does not succeed – visit the ChemCollective site, download manually the archive of Virtual Lab for offline use (for example, an international version for Windows), and ask your administrator to extract the archive files into the filter directory (path_to_moodle_on_server/filter/vlabemebed) according to the instructions given in n. 5 of the README.md file (access mode: https://raw.githubusercontent.com/ssemerikov/moodle-filter_vlabembed/master/README.md).

Running a virtual lab is possible only with the presence of the main XML file and a set of files at the appropriate path.

2.2 The Ways of Implementation

Start a virtual lab is possible in several ways:

1. To insert a link in the form of http://address_of_your web-site_moodle/path_to_main_file.xml into the block [vlab] ... [/vlab].
2. To upload a separate problem, which is contained in the filter directory, select the necessary files to run it in paragraph 4 from the list below.
3. Create a separate directory on the site and download the necessary files from an external source.
4. Download the required files from an external source, and upload them in specially created course directory or attach them to the document, and then insert a link to the main XML file into the block [vlab] ... [/vlab].

The downloadable archive vlab_ukr.zip (by the links in the settings of the filter) and vlab.2.1.0.int.zip (from the ChemCollective site) both have an identical problems set.

The following table lists the files and virtual laboratories for which they are needed (see Table 1).

Table 1. Lists the files and virtual laboratories

Title	Author	Problem description	Main file and directory files	Path
Default Lab Setup	Mike Karabinos	Contains the species, reactions, and solutions used by the Default Stockroom of the Virtual Lab.	Default.xml /default/	assignments
Step by Step Demonstration	Emma Rehm	An introductory walkthrough detailing some of the most commonly used features of the Virtual Lab.	Walkthrough.xml /walkthrough/	assignments
Dilution Problem 1	David Yaron	Dilution of a glucose solution.	Dilution.xml /dilution/	assignments/molarity
Dilution Problem 2	Mike Karabinos	Preparation of a stock solution from a concentrated acid.	Dilution2.xml /dilution2/	assignments/molarity
Sucrose Problem	Jordi Cuadros, Tim Palucka	Molarity, molality, mass percent, mole fraction, understanding concentrations.	Concentration1.xml /concentration1/	assignments/molarity
Making Solutions from solids	Jordi Cuadros, Mike Karabinos	Making salt solutions at different concentration.	Molarsoln.xml /molarsoln/	assignments/molarity
Metals Density Problem	Jordi Cuadros, Tim Palucka	Identify metals from their density.	Metals.xml /metals/	assignments/molarity
Liquid Density Problem	Jordi Cuadros, Tim Palucka	Identify a liquid from its density.	LiquidDensity.xml /liquiddens/	assignments/molarity
Alcohol Density Problem	Jordi Cuadros, Tim Palucka	Determine the concentration from the density of the solution.	Alcohol.xml /alcohol/	assignments/molarity
Jello Problem	Donovan Lange	In this problem, students mix together solutions in an attempt to control their col-	Jello.xml /jello/	assignments/stoichiometry

		or change.		
Oracle Problem	Donovan Lange	Limiting reagent problem to determine the stoichiometry of a reaction.	Oracle2.xml /oracle2/	assignments/stoichiometry
Oracle Problem 2	Donovan Lange	The limiting reagent problem from above with a more challenging solution.	Oracle.xml /oracle/	assignments/stoichiometry
Textbook Style Limiting Reagents Problems	David Yaron, Mike Karabinos	Solving text-book style limiting reagent problems using the virtual lab.	Hslimit1.xml /hslimit1/	assignments/stoichiometry
Open-ended Text Book Style Limiting Reagent Problem	David Yaron	Design an experiment to answer a limiting reagent style problem.	Hslimit2.xml /hslimit2/	assignments/stoichiometry
Predicting DNA concentration	David Yaron	Predict the results of a limiting reagents problem involving strings of DNA.	Dnabind.xml /dnabind/	assignments/stoichiometry
DNA/Dye Problem 2	David Yaron	In this limiting reagent exercise, students develop an experiment to determine the concentration of an unlabeled container.	DnaDye2.xml /dnadye2/	assignments/quant
Unknown Concentration Problem	Mike Karabinos	Determine the concentration of Silver ion in a Silver Nitrate solution.	Silver.xml /silver/	assignments/quant
Gravimetric Determination of Arsenic	Jordi Cuadros	Determine the amount of arsenic present in soil samples.	ArsGrav.xml /arsgrav/	assignments/quant
Cobalt Lab	Bob Belford	An experiment that looks at Cobalt (II) Complexes LeChatlier's Principle.	Cobalt.xml /cobalt/	assignments/equilibrium
DNA Binding Problem	David Yaron	Explore equilibrium constants in biochemical systems.	Dnabind.xml /dnabind/	assignments/equilibrium
Temperature and the solubility of salts	Rob Belford, David Yaron	Examine the solubilities of salts based on temperature.	Sol.xml /sol/	assignments/solubility
Determining the solubility product	Rob Belford, David Yaron	Determine the solubility product constant (K_{sp}) for various solids.	Sol2.xml /sol2/	assignments/solubility
Solubility De-	David	Determine the solubility of	CuClSolu.xml	assign-

termination Problem	Yaron	CuCl at different temperatures.	/cuclsolu/	ments/solubility
Thermochemistry Problem 1	David Yaron	Observe and then determine the heat of reactions in aqueous solutions.	Thermo.xml /thermo/	assignments/thermochemistry
Coffee	Tim Palucka, David Yaron	Create a solution of Coffee with a desired temperature.	Coffee.xml /coffee/	assignments/thermochemistry
Heats of Reaction – Hess' Law	Barry Charington	A demonstration of Hess' Law using three reactions, the solubility of NaOH in water and in HCL and the reaction of a solution of HCL and a solution of NaOH.	Heatrxn.xml /heatrxn/	assignments/thermochemistry
Coolant I	Tim Palucka, Jordi Cuadros	Measure and compare the heat capacity of an unknown liquid.	Freeze.xml /freeze/	assignments/thermochemistry
Coolant II	Tim Palucka, David Yaron	Measure and compare the heat capacity of an unknown liquid with an unknown density.	Freeze2.xml /freeze2/	assignments/thermochemistry
Camping 1	Tim Palucka, David Yaron	Measure the enthalpy of a reaction.	ThermoQ1.xml /thermoQ1/	assignments/thermochemistry
Camping 2	Tim Palucka, David Yaron	Determine change in the enthalpy of a reaction as the concentration of reactants are varied	ThermoQ2.xml /thermoQ2/	assignments/thermochemistry
Camping 3	David Yaron, Jordi Cuadros	Create solutions that when mixed, increase to a certain temperature.	ThermoQ3.xml /thermoQ3/	assignments/thermochemistry
ATP Reaction (Thermochemistry and Bonding)	David Yaron, Jordi Cuadros	Determine the enthalpy of the ATP reaction.	Atp.xml /atp/	assignments/thermochemistry
Strong Acid Problems	Rea Freeland	Text book style strong acid and base problems that can be checked using the virtual lab.	StrongAcid.xml /strongacid/	assignments/acidbase

Weak Acid Problems	Rea Freeland	Text book style weak acid and base problems that can be checked using the virtual lab.	WeakAcid.xml /weakacid/	assignments/acidbase
Method of Successive Dilutions	Bob Belford	Exploring the pH Scale by the method of successive dilutions.	Dilut.xml /dilut/	assignments/acidbase
Prelab Exercises: Acid Base Titration	Sophia Nussbaum	A collection of questions and exercises to complete before performing an acid/base titration.	PrelabAcid.xml /prelabAcid/	assignments/acidbase
Standardization of NaOH	David Yaron	In this prelab exercise, students standardize a solution of NaOH using KHP.	Titration.xml /titration/	assignments/acidbase
Unknown Acid and Base Problem	David Yaron	In this exercise, students graph the titration curve of an unknown acid and base to determine their pKa's and concentrations.	Unknownacid.xml /unknownacid/	assignments/acidbase
pKa and Weak Acid Problem	David Yaron	Determine the pKa and concentration ratio of a protein in solution.	Buffer.xml /buffer/	assignments/acidbase
Buffer Creation Problem	Sophia Nussbaum	An exercise to design a buffer solution with specific properties.	MkBuffer.xml /mkbuffer/	assignments/acidbase
DNA/Dye Problem	David Yaron	Students examine equilibrium and buffer solutions in a biological setting.	Dnadye.xml /dadye/	assignments/acidbase
Redox Reaction Series	Barry Charington	Students prepare an oxidation reduction reaction series from experimental data collected in virtual lab.	Redox.xml /redox/	assignments/redox

Filter embeds any assigments (both local and global). This filter will replace links to a Vlab file (.xml) in [vlab]…[/vlab] block with a java applet that plays that ChemCollective Virtual Lab inline. The plugin interface is very simple and easy to use for students (see Fig. 1).

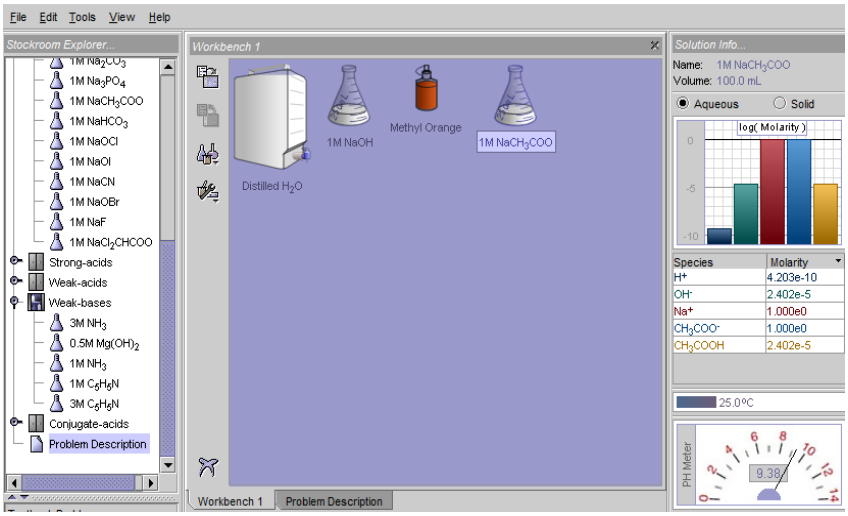

Fig. 1. Interface of VlabEmbed plugin Moodle for the chemistry education

3 Conclusions and Outlook

New VlabEmbed plugin very beneficial for the chemistry teachers. It helps in embedding ChemCollective virtual lab problems using the Vlab Java applet. This plugin greatly expands the capabilities of Moodle to support teaching chemistry, particularly in the chemical experiment.

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