Co-funded by the
Erasmus+ Programme
of the European Union

Online Labs

August 2022

Project acronym:	**TeComp**
Project full title:	**Strengthening Teaching Competencesin Higher Education**

	in Natural and Mathematical Sciences
Project No:	598434-EPP-1-2018-1-RS-EPPKA2-CBHE-JP
Number of grant contracts	2018-2467/001-001
Web address of project	www.tecomp.ni.ac.rs
Funding Scheme:	Erasmus+
Coordinator Institution:	University of Niš
Coordinator:	Prof. dr. Jelena Ignjatović
Project duration:	15.11.2018. – 14.11.2022.
Work package:	**WP4 – The formation of online learning environment**
Lead organization of WP4:	P3 – UNS
Task 4.3	The integration of online technologies into traditional courses
Version of the document:	v.03
Status:	Final Draft
Dissemination level:	Internal

The report is made by Andreja Tepavčević

Contributions by:

Sladjana Dimitrijević, University of Kragujevac

Jelena Matejić, University of Niš

Jelena Ignjatović, University of Niš

Tatjana Andjelković, University of Niš

Ivana Kostić-Kokić, University of Niš

WP4 The formation of online learning environment

4.3. Online labs formed

In the framework of activity 4.3, the integration of online technologies in laboratory exercises and scientific experiments was conducted. The main goal was to enable students to participate in experiments from remote locations, which could alleviate the problem of insufficient quality laboratory equipment in some partner country universities.

Within this activity, pilot projects for integrating online technologies into a certain number of laboratories at the partner universities were launched.

Another important reason for organizing online laboratories was the pandemic because it was difficult to organize good experimental work for students during the pandemic. However, with additional effort, with smaller student groups and more classes held in laboratories, that was overcome, and partially students were present in the lab, and some were watching the recorded experiments. Also, some of those classes were organized completely online or recorded for students.

Remote access laboratories were used for:
(a) demonstration and observation of the experiment;
(b) conducting measurements (especially in real-time);
(c) for manipulating instruments in experiments;
(d) for remote cooperation and discussions.

Remote access laboratories were organized at
University in Kragujevac (Physics, Chemistry, Informatics), 5
University of Novi Sad (Physics and Chemistry), 6
University of Niš (Chemistry), 3
University of Belgrade (Biology, Physics), 2.

At the University of Gjirokastra, in the physics and chemistry departments, the experiments were organized online in a way that the students watched experiments live in MS Teams, or professors recorded them and published them for the students on the same platform.

1. University of Kragujevac

During the pandemic, it was difficult to organize good experimental work for students, but with additional effort, with smaller students' groups and more classes held in laboratories, that was overcome. Also, some of those classes were organized online or recorded for students. The list of courses that have included online experiments is given in the next table and some basic details about them.

	Subject	Study program	Number of students	Type of online exercises	Used tool
1.	Laboratory in electromagnetism and optics	Bachelor studies in Physics	12	Recorded videos	Movie maker
2.	General and inorganic chemistry didactics	Bachelor studies in Chemistry	6	Virtual laboratory	Labster
3.	Organic chemistry didactics	Bachelor studies in Chemistry	5	Virtual laboratory	Labster
4.	School experiments in chemistry II	Master studies in Chemistry	7	Virtual laboratory	Labster
5.	Internet of Things	Bachelor studies in Informatics	40	Virtual laboratory	Microsoft Teams, https://tinkercad.com, https://www.golabz.eu/search?keys=cvjetkovic

2. University of Niš

Remote Access Laboratory in Science courses stands for any communication that takes place between the laboratory with the instrument on one end and the user (educator, student, researcher) on the other end via internet interaction and devices (computer, laptop, tablet, and mobile phone) was performed several times during TeComp project implementation in the period 2019-2022.

Remote access laboratories were used for: (a) demonstration and observation of the experiment; (b) conducting measurements (especially in real-time); (c) for manipulating instruments in experiments; (d) for remote cooperation and discussions.

This approach was successfully applied at the University of Nis in the period 2019-2022: (a) during the delivery of 3 courses in the chemistry domain; (b) as a subject matter for 2 Master theses, and (c) during online oral lecture. Here is the list with more details about the application of the Remote Access Laboratory in Science at the University of Nis:

(a) Marijana Ilić, E-learning and distance learning as a teaching method in the active learning chemistry, Masterwork, University of Nis, Faculty of Science and Mathematics, Niš, October 2019.

Tijana Jovanović, Creating online knowledge tests - comparison of e-learning platforms, Masterwork, University of Nis, Faculty of Science and Mathematics, Niš, October 2021.

(b) Course Introduction to Environmental Chemistry ((Bachelor Academic Study program: Chemistry) delivered during 2021/22 with enrolled 25 students, presented usage of Ion Chromato-graph by Remote Access option. With the application of AnyDesk Remote Access Software, remote access to analytical instruments and direct control of instrument operation remotely were achieved.

Course Agricultural Chemistry ((Master Academic Study program: Applied Chemistry and Management) delivered during 2021/22 with enrolled 10 students, presented usage of Ion Chromatograph by Remote Access option. With the application of AnyDesk Remote Access Software, remote access to analytical instruments and direct control of instrument operation remotely were achieved.

Course Environmental Chemistry (Master Academic Study program: Ecology and Environmental Protection) delivered during 2021/22 with enrolled 10 students, presented

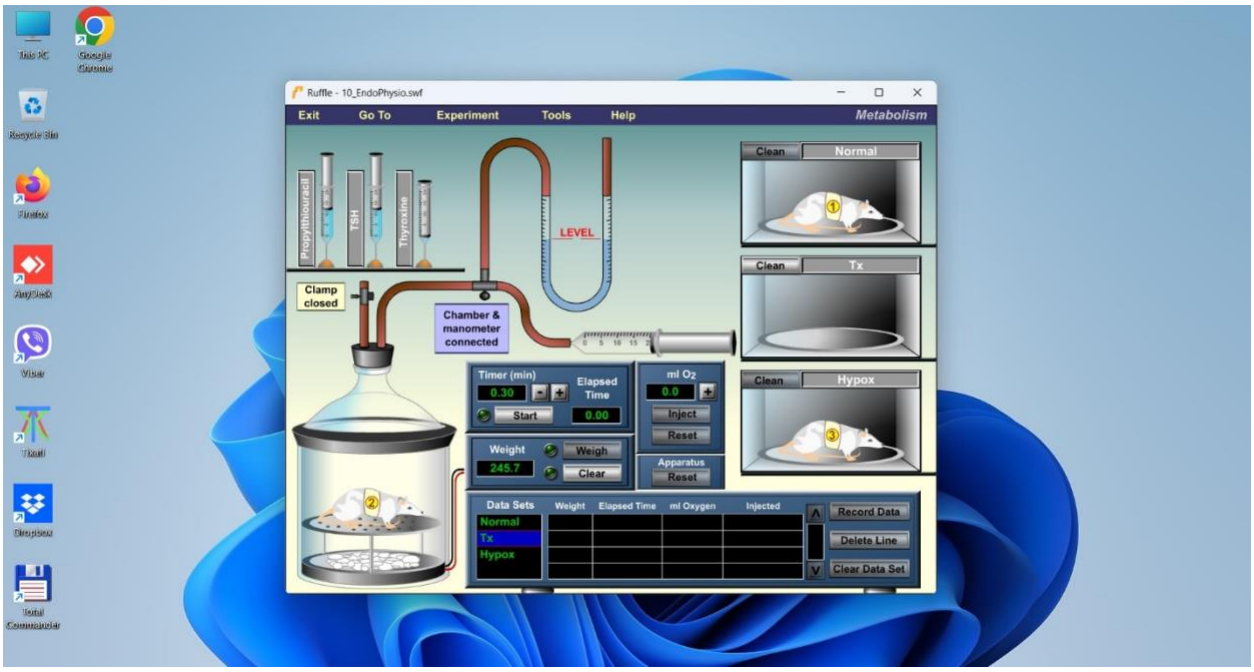
usage of Ion Chroma-tograph by Remote Access option. With the application of AnyDesk Remote Access Software remote access to analytical instruments and direct control of instrument operation remotely was achieved.

(c) Online oral lecture: Problems and solutions in Chemistry Instrumental Techniques Teaching by Remote Access Laboratories. During this presentation, a micro class was demonstrated with an emphasis on an adequate pedagogical-methodological approach for the organization of remote access laboratory. Within the lecture: Determination of anions in carrot and spinach (Study program: Master Chemistry, Course: Chemistry of Water and Soil), remote access to the Ion Chromato-graph was organized. The training was attended by around 10 teachers from Universities in Niš, Kragujevac, Novi Sad, Belgrade, and Korca. During 1 hour of training, the main topics that were covered by the presentation were: What are Remote Access Laboratories (RAL)? Advantages of RAL (pros); Disadvantages of RAL (cons); How to organize RAL (Personal and Technical background); How to organize a class with RAL (needed time for the analysis, parameters selections to be controlled by students, samples selection); Micro class as example (5 minutes): lecture slides – demonstrator + instrument – AnyDesk chromatogram – Slide conclusion. After training presented by organizer, there was discussion with participants regarding differences between remote and virtual laboratories.

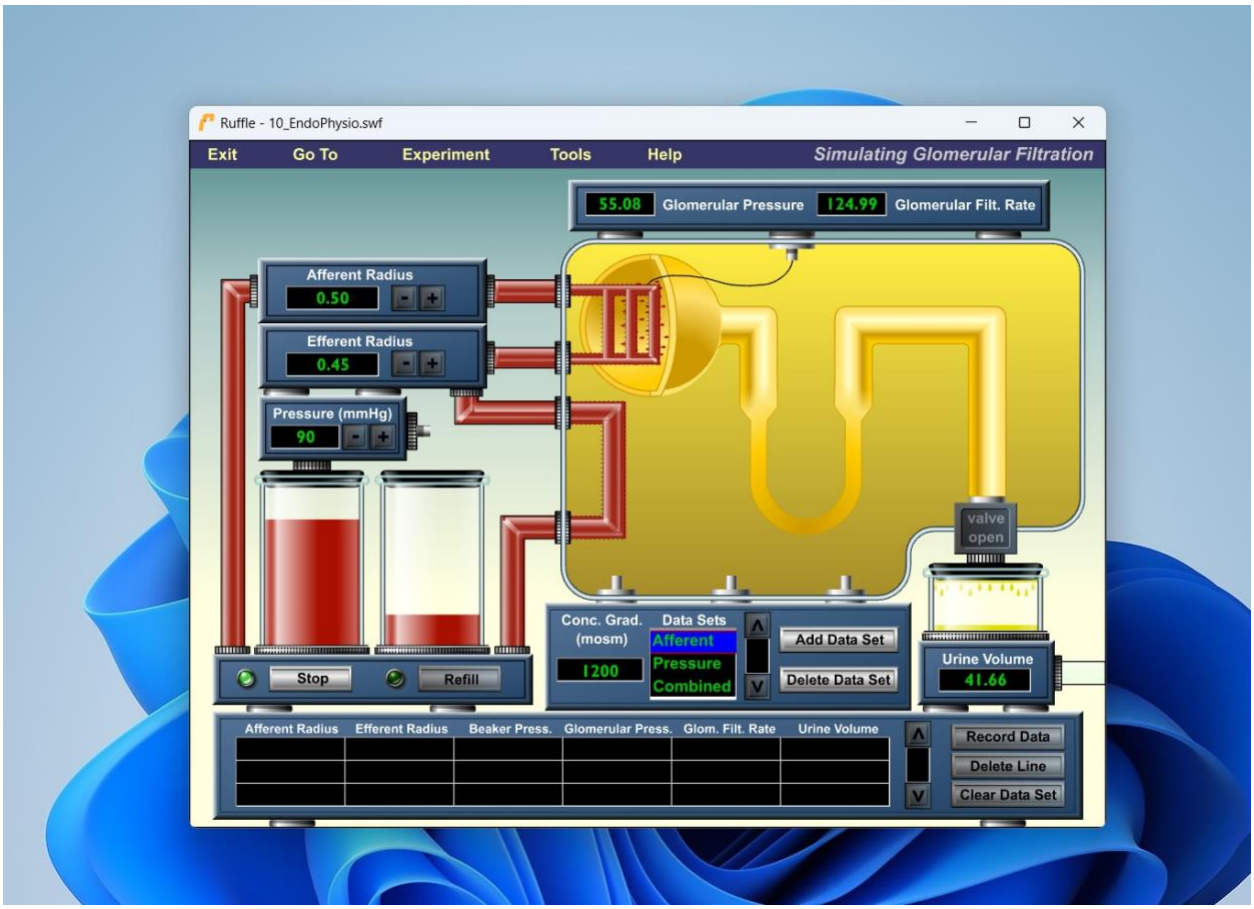
3. University of Belgrade

At University of Belgrade, experimental work was organized remotely at Faculty of Biology and Faculty of Physics.

At Faculty of Biology, a part of the experimental work in the field of physiology and endocrinology was organized remotely. The students showed interest in this approach to teaching, and the experimental exercises significantly contributed to the understanding of the planned material. The number of students who participated in performing such experimental work was about 130 per year.
In the fifth semester of BSc studies, about 30 students of the ecology study group attend a course in animal physiology. During that course, teaching was modernized using the specialized PhysioEx program package, which made it possible to teach remotely. Also, in the seventh semester of BSC studies, about 95 students attend a course in endocrinology. In that course, the PhysioEx program package was also used, so the distance learning students were able to learn in detail about the principles of functioning of individual endocrine axes. In addition, the teaching process has been modernized by the use of applications intended for the production of educational video materials, such as Animaker.

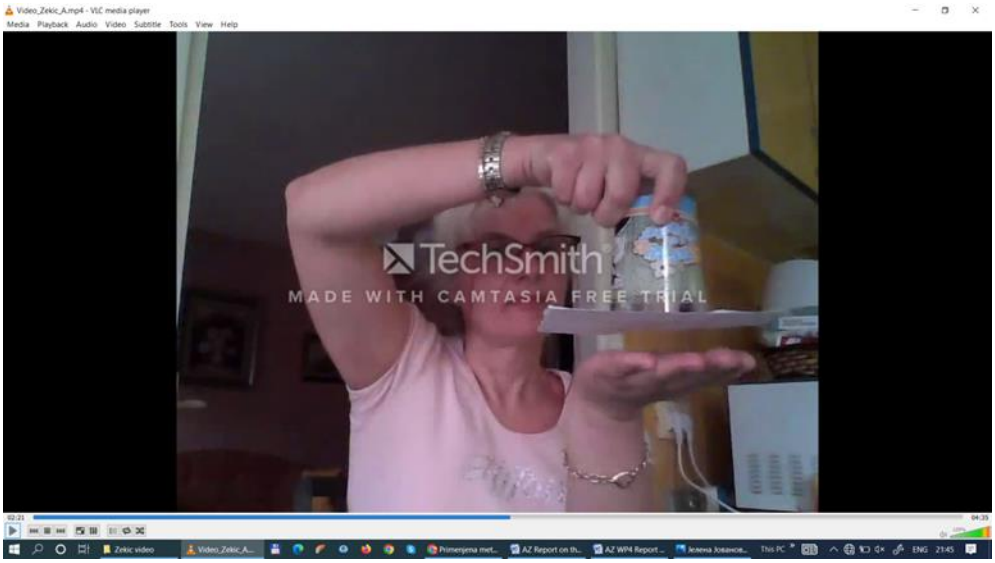


Determination of the influence of thyroid hormones on the metabolism of experimental animals - PhysioEx – Endocrinology course



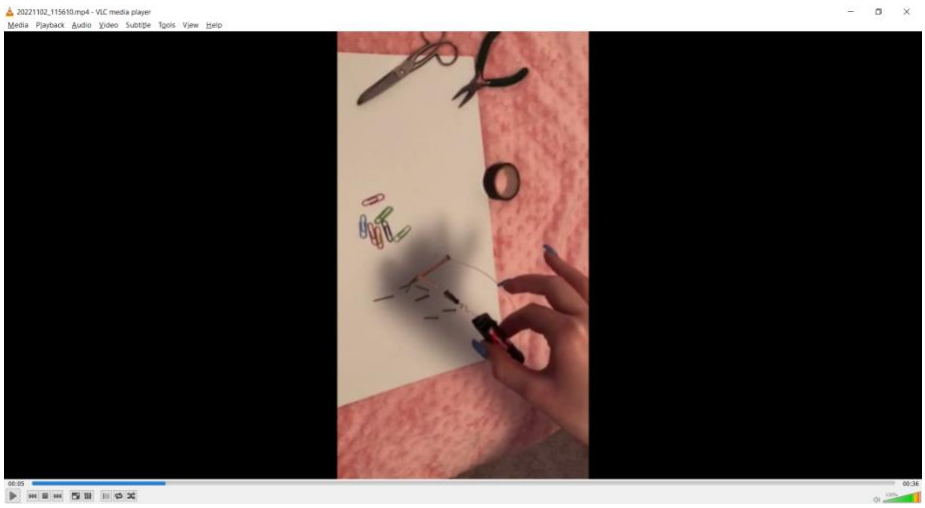
Determination of the influence of interstitial osmolality and capillary blood flow on the glomerular filtration rate - PhysioEx - Physiology course

Laboratory work is very important in physics. The conditions of the pandemic motivated teachers at the Faculty of Physics to design the laboratory e – classes. In this regard, several courses organized by the Faculty of Physics have been modernized as a result of the implementation of equipment and skills acquired during the TeComp project. Some of those subjects are: Modern Teaching Tools, Applied Methodology of teaching Physics



Course: Applied Methodology of teaching Physics - distance learning; guided laboratory work

Course: Modern Teaching Tools - using project equipment for distance learning.



Course: Modern Teaching Tools - using project equipment for distance learning.

4. University of Gjirokastra

During the pandemic, organizing good experimental work for students was difficult. Our professors performed the laboratory work at the faculty, with the students watching live in MS Teams, or they recorded it and published it for the students in the same platform. Specifically, this was done by physics and chemistry professors. Informatics professors, used prerecorded tutorials to help students with exercises of Informatics laboratory classes.

5. University of Novi Sad

At University of Novi Sad online remote access laboratories were organized at Physics and Chemistry Departments.

At the Department of Physics, Course Oscillations and Waves (Bachelor Academic Study Program: Physics) delivered during 2021/22. with enrolled 28 students, presented usage of Phet simulations for online laboratory exercises:

Hooke's Law, Masses and Springs, Pendulum Lab, Waves Intro, Fourier: Making Waves, Wave on a String, Wave Interference.

The students were also introduced to the free application for smartphones Phyphox, which, with the help of sensors on the phone enables measurements in the field of Acoustics: sound generator, sound amplitude, Doppler effect, and sound spectrum.

At the Department of Chemistry, Biochemistry and Environmental Protection, during the Covid pandemic, in order to reduce the number of students and their stay in the laboratories, we recorded experiments in cases where the exercises were simple and do not require developed manipulative skills, but it is only important to observe what happens during the reaction, what the products are, and draw conclusions based on that. some conclusions. For this purpose, we have developed electronic practicums with recorded trials for many subjects. On the link:
https://drive.google.com/drive/folders/1WEtCOGDLIHs9VDF09XcZ6JAmuF2bCwmM?usp=sharing

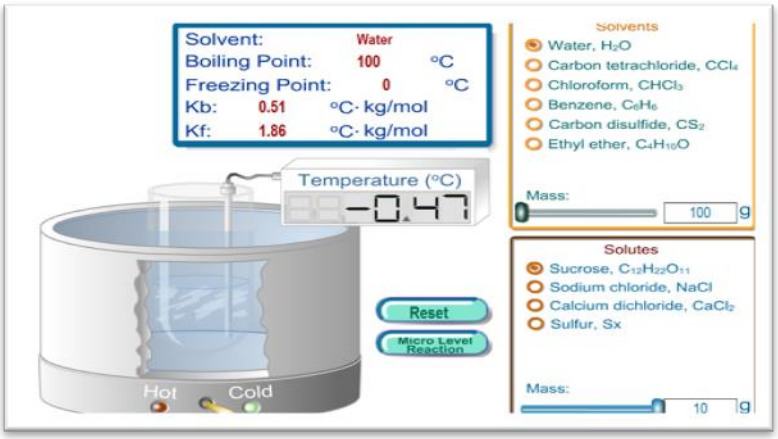
it is possible to see the practicum for Analytical Chemistry I (it is about qualitative chemical analysis), and at the link:

https://drive.google.com/file/d/1bFNkMmJBipSTvJmxwkLr7NS2mdyBuM94/view?usp=sharing

is an electronic practicum for the subject Inorganic Chemistry (part of the content on metals). It can also be accessed by scanning a QR code.

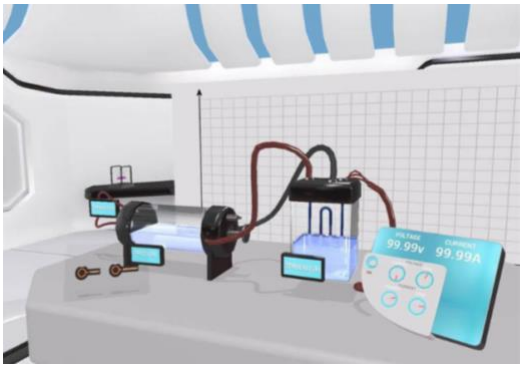
2. COMMERCIAL AND OPEN-SOURCE VIRTUAL EXPERIMENTS - SIMULATIONS

The application of the steps of the scientific method as a learning strategy is studied in the teaching of the subject Methods and techniques of learning chemistry. In those exercises, a simulation of an experiment (from an open-source source) is used to illustrate the colligative properties of solutions of solid substances in water, in which students, by changing the parameters and processing the experimental results, derive an expression for calculating the lowering of the freezing temperature and the elevation of the boiling point of the solution compared to the pure solvent.



Colligative properties of solutions - simulation of the experiment

Also, in the teaching of physical chemistry, general chemistry and biochemistry, purchased simulations of experiments are used in a 360o environment that can be used on a computer or with VR glasses (which we also have). Students move through the lab and use controllers to manipulate substances, operate instruments, measure and record experimental results.



Ideal gas law - virtual experiment

3. RECORDED EXPERIMENTS IN VIRTUAL REALITY TECHNOLOGY

We have recorded several experiments for different subjects that students can watch as movies in a 360o environment. They use them during the preparation for experimental exercises or during the preparation of the isit as a reminder for the performed experiments.

Work with cell cultures in laminar

4. VIRTUAL TOURS THROUGH LABORATORIES

Within the course Augmented and virtual reality in chemistry, students create virtual tours through chemical laboratories. One of these projects is familiarization with the basic laboratory utensils and equipment used in general and inorganic chemistry laboratories, which is necessary for all first-year students. The virtual tour is made in 3D space and can be viewed using VR glasses (via the Google Cardboard application) or using a computer. The virtual tour includes explanatory films, images and a knowledge test (available on the link and via QR code). A virtual tour through the cell culture laboratory is also attached.

https://www.thinglink.com/mediacard/1504028851246727169

Virtual tour - Basic chemical utensils and dishes in general chemistry

5. REMOTE ACCESS TO CHEMICAL LABORATORIES

(This has only been tried once, but it is planned to develop and implement such exercises in various subjects).

As part of the exercises in the Ecotoxicology subject, distance learning was organized during which students, using the Team Viewer application, accessed the computer that runs the analytical instruments from their homes. Through one screen, they could monitor the introduction of samples in real-time (it was done by a laboratory technician in front of the camera) and the operation of the instrument, or they could switch to another screen that was connected to the software of the instrument, they could access it, process the obtained spectra and that's how they analyze the sample.

Virtual tour - cell culture laboratory

Remote access to exercises in the course Ecotoxicology

University of Niš

The TeComp Consortium

www.tecomp.ni.ac.rs
e-mail:
tecomp@ni.ac.rs

tecomp.p2018@gmail.com

Co-funded by the
Erasmus+ Programme
of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein