UniSchooLabS: Remote access for schools to university science labs

Summary:

The UniSchooLabs best practice links the traditional science lessons with the use of remote and virtual university science laboratories. Students are given the opportunity to work with real scientific infrastructures and eScience applications and engage in interesting and fascinating activities that allow them to witness how real scientific work is done. Within the framework of this best practice a catalogue of available labs and accompanying best practices have been developed that allow students to interact and experiment with scientific instruments and learn about science through minds-on and hands-on activities.

Aims:

- **To introduce to students the concept of scientific inquiry.** Students conduct science experiments following the inquiry based teaching approach. They are asked to document every step of their inquiries and produce scientifically accurate results.
- **Facilitate the implementation of a set of good practices that allow the effective use of remote and virtual labs.** Teachers and students are provided with a set of good practices that are connected to the school curriculum and guide them to use the labs as efficiently as possibly. Thus the interaction and the experimentation with the labs are done according to set of already tested guidelines that ensure the effective use of the labs.
- **To provide opportunities for interaction between schools and universities.** Through the use of the remote and virtual university science laboratories of the UniSchooLabS practice, students and teachers are given the opportunity to interact with the creators of the labs and respective scientists collaborate with them and learn first hand how scientists work.

Main activities:

Teachers are provided with all the necessary tools that allow them to perform activities with their class that are connected to the school curriculum using remote and virtual labs. The UniSchooLabS toolkit offers to the teaching community a catalogue of available labs and respective guidelines that teachers may deploy in order to carry out their activities. Teachers act only as facilitators; they prepare the conduction of the experimentations by using existing activities or they may design their own, tailored to the exact need of their class. Students are the main actors of all the activities as they are given the tools in order to perform the activities on their own and document the whole procedure through the UniSchooLabs notebook that is available in every activity. Teachers may also collaborate with the lab owners in order to produce new and effective activities, while they are also given the opportunity to interact with other teachers within the UniSchooLabs teachers' community.

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PATHWAY

Narrative:

The UniSchooLabS practice aims to transform the current science teaching practices by introducing hands-on and minds-on activities that are realized through the use of remote and virtual university science labs. The use of remote and virtual labs gives the opportunity to every teacher to perform scientific experiments with their students. Thus, even students in schools where science labs are not available have the opportunity to conduct experiments and learn by doing through their computers.

The UniSchooLabS toolkit offers to teachers a list of available labs that cover numerous subjects of physics and chemistry and teachers may choose from these labs in order to realize their activities. Each lab is accompanied by good practices that help teachers integrate the use of the labs in their every day lessons. The good practices are activities that have already been used in different contexts and they have already proved their efficacy. They all follow the inquiry based teaching approach where students have the leading role and teachers merely facilitate the procedure. The tool that has been developed allows the teachers to provide their students with all the necessary supporting materials and basic guidelines while students may write down their ideas and record the experimental procedure and outcomes in a digital notebook that each activity is provided with.

Moreover, teachers are also given the tools to create their own activities involving any of the available labs. Certain guides are offered so as to help teachers design effective inquiry based activities.

The involved inquiry based activities include a preparatory phase that allows students to identify the problem at hand, make their predictions and design their investigation plans and experiments. The second part of the exercise is the experimental procedure where students are asked to use one of the labs and conduct an experiment that is related to the problem at hand. Using their notebook, students may work on their own or in groups, document the procedure and upload their results in the UniSchooLabS toolkit. Thus the entire class' work is at the disposal of the teachers as it is properly organized and stored along with the activity in an easily accessible and easy to use environment. All activities are finished with a last part where students are asked to assess their results, come up with conclusions and scientifically correct explanations and compare their explanations with their initial predictions.

The educational methodology that is followed within the UniSchooLabS best practice is in accordance with the recommendations of the High Level Group on Science Education (Rocard Report, "Science education now: a Renewed pedagogy for the future of Europe , 2007)

Overall, students work in groups to perform scientific experiments, make observations and collect data within realistic contexts and explore different areas of physics and chemistry. Thus they acquire new knowledge through hands-on and minds-on activities that are stimulating and engaging.

Finally teachers are also given the opportunity to interact with other teachers from numerous European countries through the UniSchooLabS on-line community, share their experiences and learn from the experience from others. Moreover they also have the opportunity to collaborate with the lab owners and developers in order to produce more effective activities.

Example: Conservation of momentum in particle collisions

(http://unischoolabs.eun.org/web/catalogue/courses/-/asset_publisher/6d9L/content/conservation-of-momentum-in-particle-collisions?redirect=%2Fweb%2Fcatalogue%2Fcourses)

In this exercise students learn about the conservation of momentum and how to use vectors through fundamental particle collisions. This exercise deploys a virtual lab that is called HYPATIA which makes use of real scientific data from the ATLAS experiment in CERN. The tracks from the particles' collisions are displayed in the analysis tool allowing students to study the fundamental particles and their interactions.

End user:
students of primary and secondary education

Involved actors:
Primary and secondary education students and teachers, university researchers and teachers

Location:
In the school class and on the web.

Languages available:
English, Greek, German, Italian

Where to find the application or case:
http://unischoolabs.eun.org/web/unischoolabs

Evaluation parameters:

This educational approach is based on the inquiry-based learning model, which aligns with the recommendations of the High Level Group on Science Education (Rocard, 2007) for the provision of increased opportunities for enhancing motivation and participation.

Connection with the curriculum:
Physics, Chemistry

Teachers' Competencies

1	subject matter/content knowledge	x
2	nature of science	x
3	Multidisciplinary	x
4	knowledge of contemporary science	x
5	variety of (especially student-centred) instructional strategies	x
6	lifelong learning	x
7	self-reflection	x
8	teaching/ learning processes within the domain	x
9	using laboratories, experiments, projects	x
10	common sense knowledge and learning difficulties	x
11	use of ICTs	x
12	knowledge, planning and use of curricular materials	x
13	Information and Communication Technologies with Technological Pedagogical Content Knowledge	x

Mapping best practices with main principles

1. Building interest in natural science phenomena and explanations:

The UniSchooLabS approach focuses on building interest in natural science phenomena and explanations by allowing students to learn about them through experimentations with virtual and remote labs. The enhancing of students interest in science through hands-on activities is the very heart of this best practice.

3. Develop multiple goals:

- **understanding big ideas in science including ideas of science, and ideas about science**
- **scientific capabilities concerned with gathering and using evidence**
- **scientific attitudes**

The F1 in Schools approach allows students not only to have a sneak preview on the science behind Formula One racing but also to develop personal thinking, leadership and teamwork skills and encourage self-study. The development of these skills is essential in generating scientific attitudes among pupils.

4. Understanding students' concepts and learning style about of science phenomena:

Students have the opportunity through advanced software to initially test their design and theoretical approach and afterwards to learn by trial and error (hands-on) about science phenomena related to aerodynamics, engineering and physics.

5. Relevance of the content to daily life of students:

The activities that are included in the UniSchooLabS toolkit concern matters of modern physics like astronomy and particle physics which are contemporary subjects and students often hear about new achievements in these fields in their everyday life.
Moreover, the content of the UniSchooLabs toolkit also involves activities that concern every day habits and phenomena like motions, issues that concern public health like the electromagnetic radiation or radioactivity. Moreover, certain activities especially in the filed of electronics help students learn about instruments that are very common in everyday life and they are also used in numerous professions.

6. Understanding science as a process not as stable facts. Using up-to-date information of science and education:

Following the inquiry based teaching approach students don't participate in the learning process just as spectators who accumulate facts and knowledge. They are the main actors of every activity, they perform experiments on their own and the acquire knowledge by doing. Thus, through inquiry, they have the opportunity to understand the very nature of science and understand that it is not a stable concept but an evolving set of big ideas that are interconnected and play a key role to our lives and the world around us.

7. Activities for gaining knowledge, not for entertainment, nor for simple imitating of results:

The activities of the UniSchooLabs best practice are carefully designed so as to achieve maximum efficiency as they are based on good practices that are tested repeatedly in different contexts and they have proved their efficiency. Moreover, the Inquiry Based Science Education methodology that is followed ensures that the impact on students' cognition is maximum. Students perform activities that are designed so as to help them perform skillfully and independently they help them develop their critical skills and think creatively. As they are the leading actors of the learning process they learn to be responsible, respond and participate and to act independently and precisely.

8. Doing science: experimenting, analyzing, interpreting, redefining explanations:

The core of the UniSchooLabS best practice is to introduce to students the concept of scientific experimentation. Students are asked to participate in learning activities that simulate in detail the experimental procedures followed by real scientists. Students are expected to identify a problem, make specific predictions on the matter, design an investigation plan and make experimentations so as to come up with answers on the subject at hand. They are asked to process and analyze the information and the data they have acquired through their experimentations and finally manage to communicate the explanation they have come to and compare them to their initial predictions.

9. Assessment: formative ~ of students' learning and the summative ~ of their progress:

By being engaged in hands-on and minds-on activities, students not only learn efficiently about the subject at hand but they are also getting acquainted with the concept of research. They learn to collect data from different sources and combine them in order to come to conclusions. Thus, the activities realized have a cognitive impact on students and they also help them learn how to learn. Each step of the learning process is documented by the students and thus teachers are able to monitor the process and have a clear idea of students' performance throughout the activity so as to assess the progress of each activity.

10. Cooperation among teachers and with experts:

Teachers work in collaboration with the lab owners and the experts from universities who have developed the respective software of the labs. Thus, they are given the opportunity to design effective lessons plans and activities and exploit the full potential of the labs.