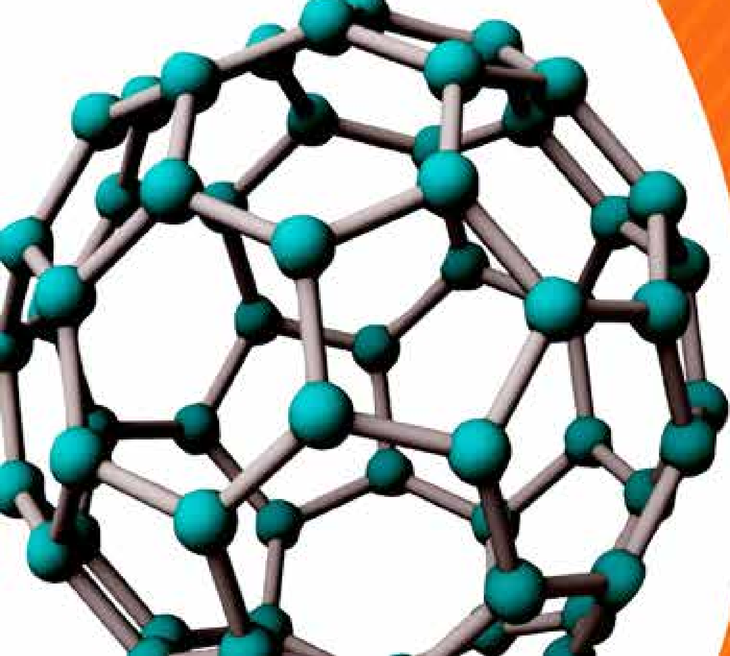
NANO TECH SCIENCE EDUCATION

www.ntse-nanotech.eu

Lifelong Learning Programme



NTSE KA3-ICT PROJECT
511787-LLP-1-2010-1-TR-KA3-KA3MP

NTSE VIRTUAL LABORATORY GUIDELINES BOOK

I. INTRODUCTION

I.1. Virtual Laboratories as Educational Applications

The virtual experiment represents the basic unit of a virtual laboratory. Through virtual experiments, students can experience a real-life situation, almost regardless of its complexity and avoiding possible danger of conducting the experiment. The major advantage is the fact that the virtual experiments - as computer-simulated processes - can be repeated until they are clearly understood. In this sense, virtual laboratories are very attractive multimedia digital resources that are easy to use by students, making the lesson time a unique and enjoyable activity featuring more practical elements.

There are many examples for virtual or interactive laboratories online. Most of them are dedicated to science education: Chemistry, Physics and Biology are the main areas targeted by these educational tools, generally presented as multimedia or interactive lessons, based on experiments, simulations, videos and/or other multimedia resources. It is well known that interactive and multimedia lessons have great capacity to provide new learning methods that will eventually boost the learning process, and thus to contribute to the formation of students' skills and abilities. By using virtual labs, teaching and learning process can be transformed into an instructive activity, an opportunity for discovery and exploitation, allowing observation of scientific principles and their application in everyday life.

Most of virtual laboratories are designed on constructivist bases, using the modern approach of student-centred learning. In this respect, the virtual experiments allow students to discover, to explore, to analyse, to imagine and find solutions, to construct their own knowledge and detail their own findings. Another important concept implemented by such educational objects is learning by doing (discovering by experiencing), an important step that guides the students to develop their own knowledge and practical skills.

The technical resources necessary to use virtual laboratories are usually not too high. Usually an updated browser and broadband internet connection, paired by speakers and multimedia projector are just enough to enable a classroom to use a VL.

However, virtual laboratories require clear understanding of the curriculum (by the teacher), also knowledge about pedagogical approaches, education standards and conventions related to the design of digital educational content, from the perspective of ergonomics and functionality.

I.2. Mission of the NTSE Project

The NTSE project aims to use information and communication technology (ICT) as a tool to make the learning of science subjects more attractive and accessible. The project target groups are students from general and vocational schools (aged 13 to 18); science teachers, and college and university students on science courses (prospective teachers). Specifically, the project is focused to create a user-friendly virtual learning area, in order to raise interest in the sciences, nanotechnologies in particular. Practically, the main objective is to create educational tools suitable for science education, not only to raise awareness of Nano subjects among learners / teachers and prospective teachers, but also to update their knowledge of Nano and inspire / motivate students to take part in science projects by providing appealing learning tools in the form of digital resources.

The proposed Nano virtual experiments are equipped with video simulations and related scenarios, to make them simpler and attractive for the users, thus promoting inquiry-based methods, encouraging learners to think about processes and phenomena by posing questions connected to real life, to find solutions and exchange information through specific channels (blog, videoconference).

The project objectives are as follows:

- to encourage students to learn about Nanotechnologies, to be engaged in explorative, meaningful and inspiring science learning through experiments and activities. By using various resources and pro-active methods, students' curiosity will be entertained, their knowledge of science and Nanotechnologies will be raised, and their imagination will be stimulated by the digital materials; last, but not least, they will be encouraged to connect their learning to nature and real life, which will help them to learn more quickly, effectively and meaningfully.

- to make science teachers in general and vocational education more enthusiastic and capable of using ICT in their lessons. They will be encouraged to be creative and make use of innovative cognitive tools to make science learning enjoyable for young learners via a Virtual Laboratory, experiments in schools, and school visits.

- to encourage university students to enter the teaching profession and, with the support of ICT, to share their enthusiasm for the sciences with young learners.

By using the Virtual Laboratory facilities, the target groups have the chance to use innovative training elements and related content; the usability and pedagogical effectiveness of the NTSE project teaching materials (videos, simulations, student and teacher guidelines) can be also evaluated through assessment grids, blog, questionnaires and reflection notes.

As the main deliverable of the NTSE project, the Virtual Laboratory (http://vlab.ntse-nanotech.eu/) serves as a platform for science lessons, as a database of teaching materials and as a hub for science-learning graphical aids, and recorded and illustrated appealing experiments on Nano-Tech. Students and teachers are able to use and refine the Virtual Lab for lessons and sharing information. In fact, the Laboratory will last long after the life of the project as an on-going platform for sharing ideas, lesson plans and information.

II. Inside the Virtual Laboratory

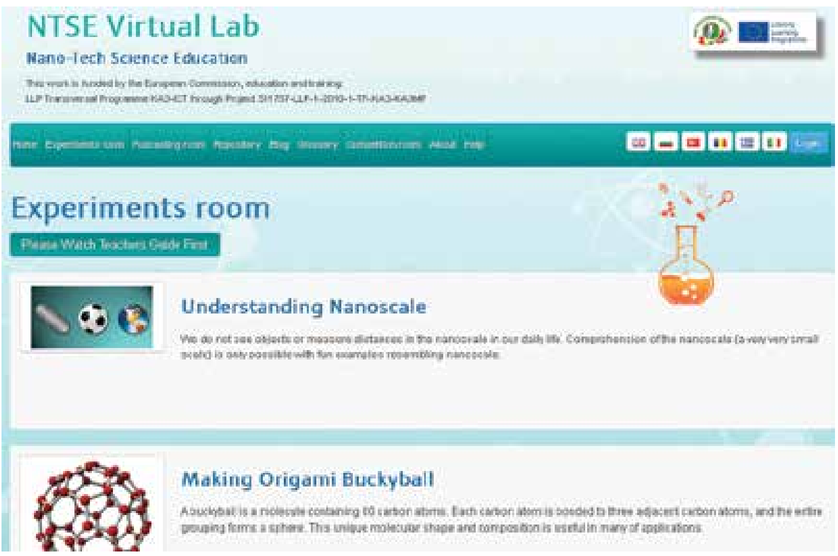
II.1. Overview

The Virtual Laboratory contains the following sections:
> Home;
> Experiment room;
> Podcasting room;
> Repository;
> Blog;
> Glossary;
> Competition room;
> About;
> Help;
> Language manual;
> Login section for the admin panel of the Virtual Lab.

1. Home section - short description with pictures of what Nanotechnology is and a Prezi presentation.

To watch the presentation click on the blue button "Watch presentation".

2. Experiment room – The Nano experiment room comprises real experiments shot by Nano-tech academics, animations created from such scenarios, students and teacher guides, and additional resources for each experiment. The main aim is to create authentic experiments that are different from published and finalised Nano projects, and to support each video with simulations and scenarios to make them simpler and more attractive for Virtual Lab users.



To open an experiment, click on the picture of the experiment.

Each experiment contains:
- Name and description of the experiment;
- Movie section;
- Interactions;
- Documents – student guides, teacher guides, assessment grids and procedure;
- Repository – links to the repository related to the topic of the experiment;
- Other – contains other links and documents useful for the experiment;
- Feedback section – a space where visitors can submit their comments or questions.

To watch an experiment movie, click on the "Movie" button and you can play the video.

To open an interaction click on the "Interactions" button and you can play the interaction.

To find out what the method is for the experiment and to access all the documents needed to implement the experiment, click on the "Documents" button.

Click on the "Repository" button to find more resources related to the topic of the experiment. You will be forwarded to the Repository for the project.

The Repository has a specific interface and presents resources (videos, articles, additional documentation) related to the Virtual Lab experiment in question.

The "Other" section opens other links or documents useful for the experiment, these are extra materials not in the Repository.

In the "Feedback" section you can contact the partners of the project or leave your comments.

3. Podcasting room – The Podcasting room comprises the video, audio and picture for the interviews related to the gender aspect, calls for VC sessions, videoconferences, classroom implementation records and dissemination activities for the project.

The podcasting room contains:

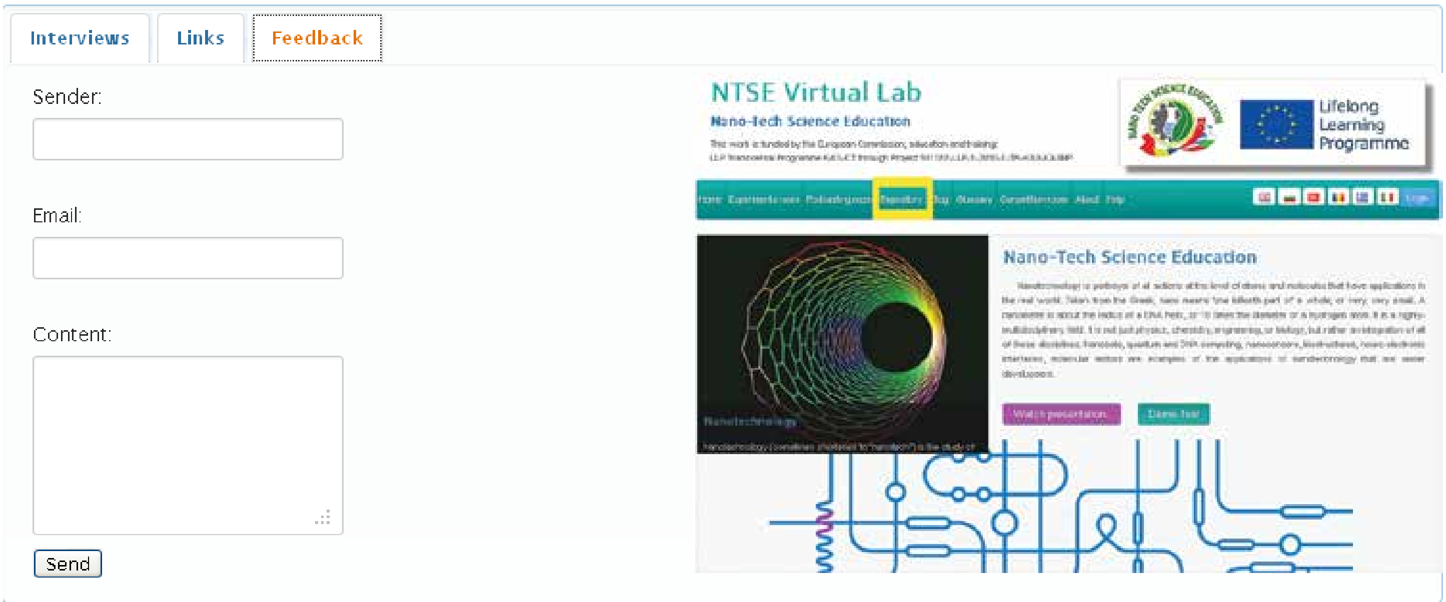
- Name and short description of the session;
- Video or interview section;
- Feedback link.

To open a podcasting activity click on the picture of the podcasting session.

When you open the topic of the podcasting entity you can play the interview, video or you can see the pictures of the podcasting activity using the “Interviews” or “Movie” button.

In the “Link” section you can find additional materials related to the topic of the podcasting activity.

In the “Feedback” section you can contact the partners of the project or leave your comments.



4. Repository - the NTSE Repository / Database has been designed to provide extra reading and reference related to Nanoscience and Nanotechnology, to be used by the virtual lab users. It includes: articles, books, chapters, posters, videos, experiments, methodological documents that introduce actual findings and research developed in different countries. The role of the Database is to update the virtual lab users’ knowledge and to raise their awareness of Nano-science and Nanotechnology.

The “Repository” button in the Virtual Lab links to the Repository page: **http://ntse.ssai.valahia.ro**

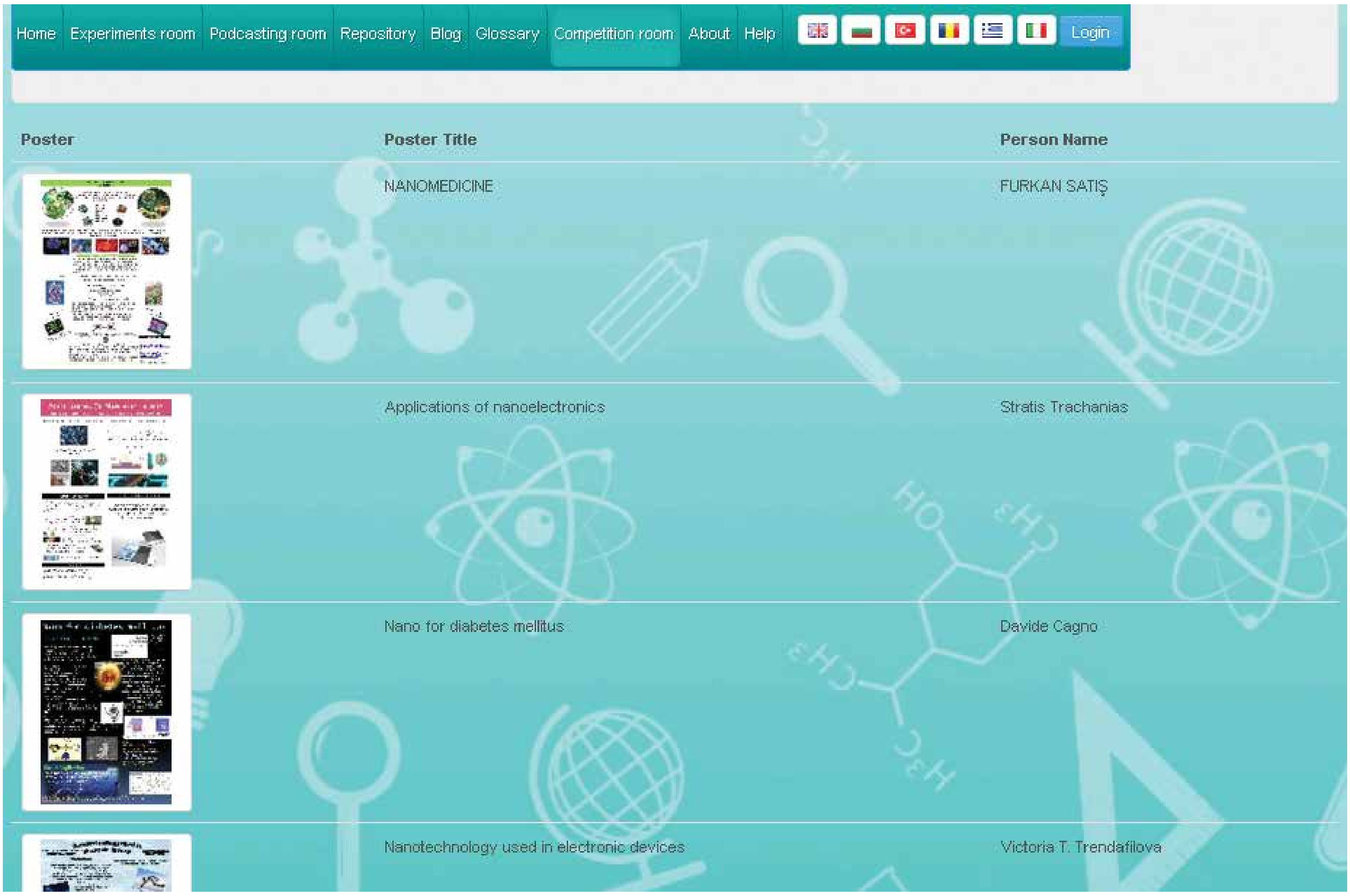
5. Blog - apart from the Virtual Lab and repository, partners have set up a portal system to enable implementers to share knowledge about the articles and implementations on project-related issues. Discussion space will be created in a blog format and will be used for making comments and submitting articles. All submitted articles will be reviewed and validated for publication after a validation process by project experts.

The "Blog" button in the Virtual Lab will link to the Blog page: **http://ntse.iacm.forth.gr/index.php**

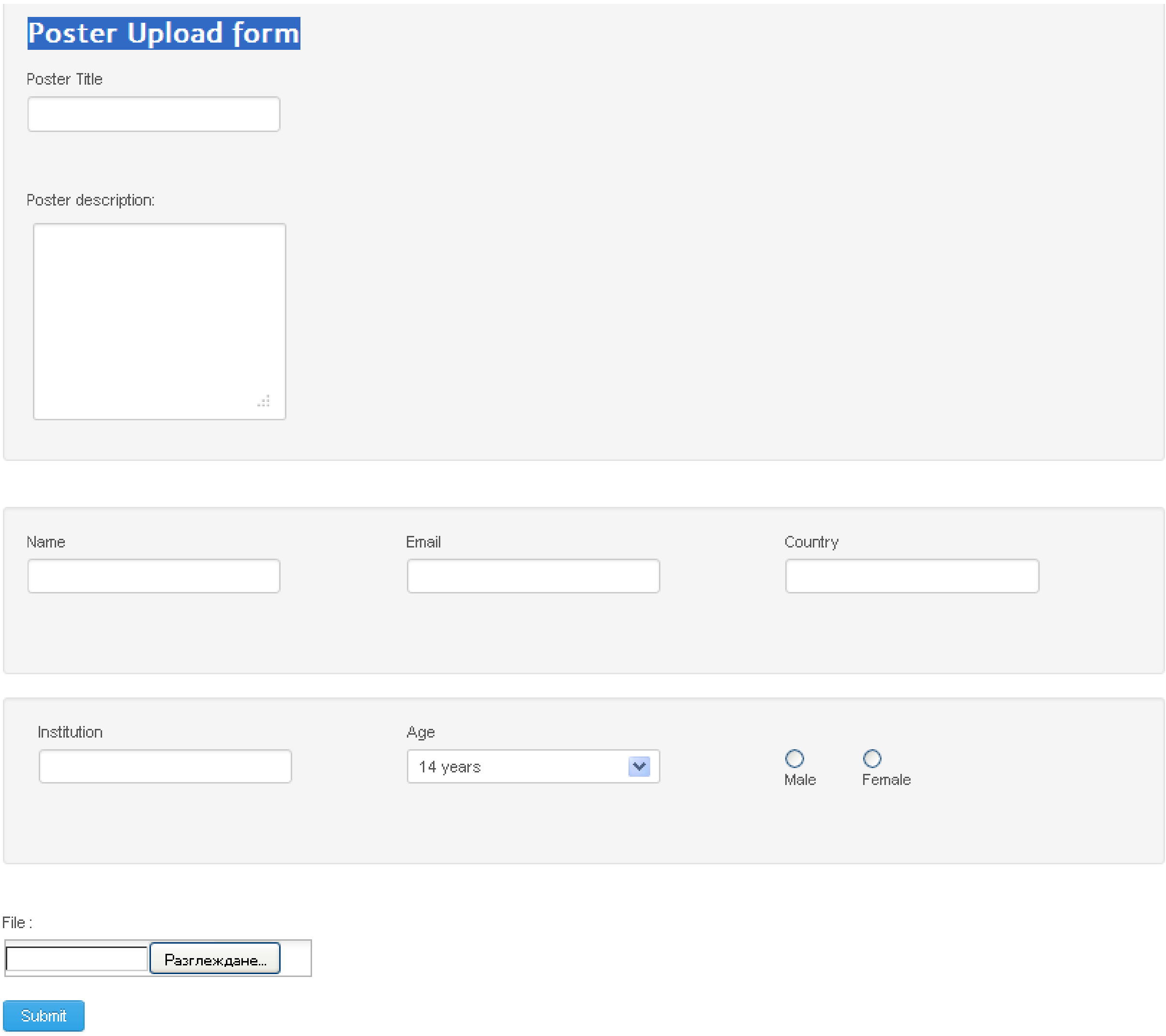
6. Glossary – a vocabulary list containing definitions of “nano” terms.

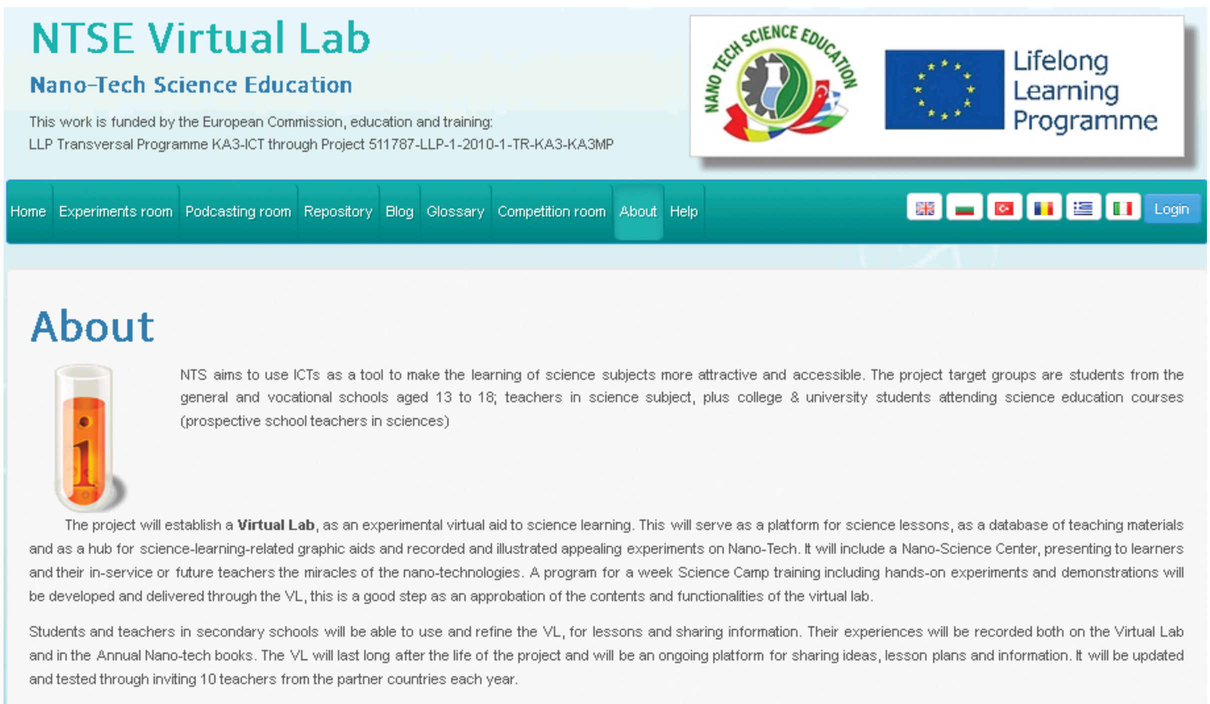
To see the definition of the nano term click on the word.

7. Competition room – contains presentations and information on Nano Competitions. Provides tools for uploading files, contains a gallery of posters and insures voting in order to cover the whole process of the Nano Competition.

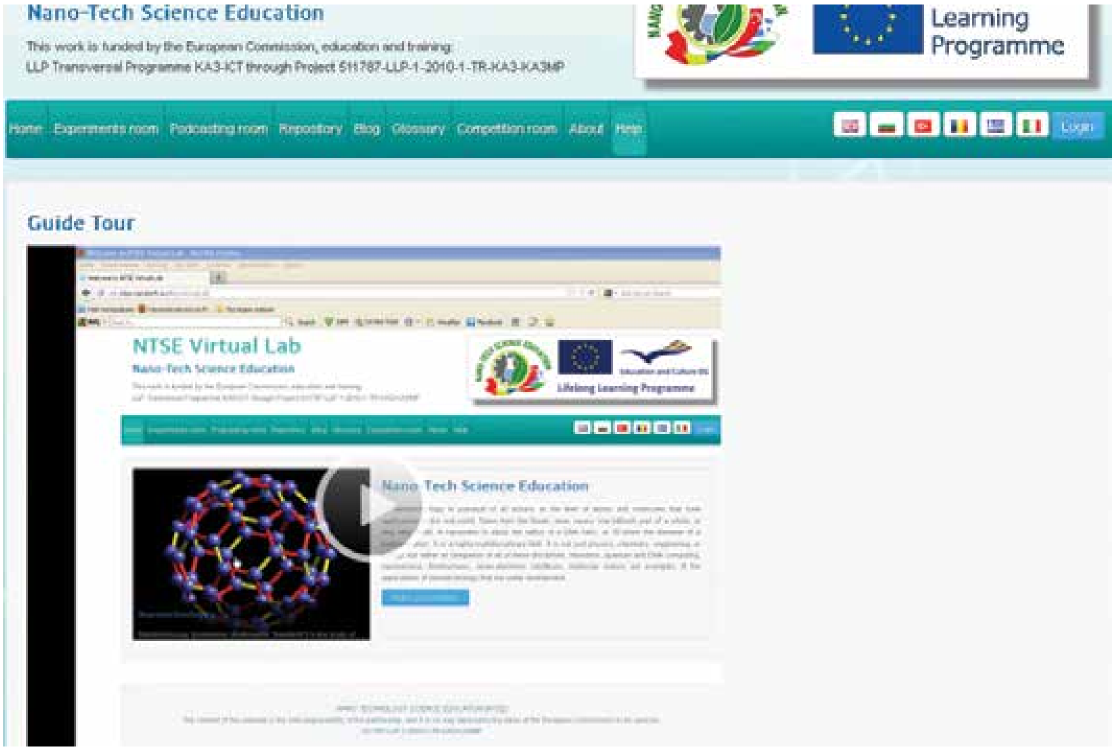


8. About – contains a short description of the project.

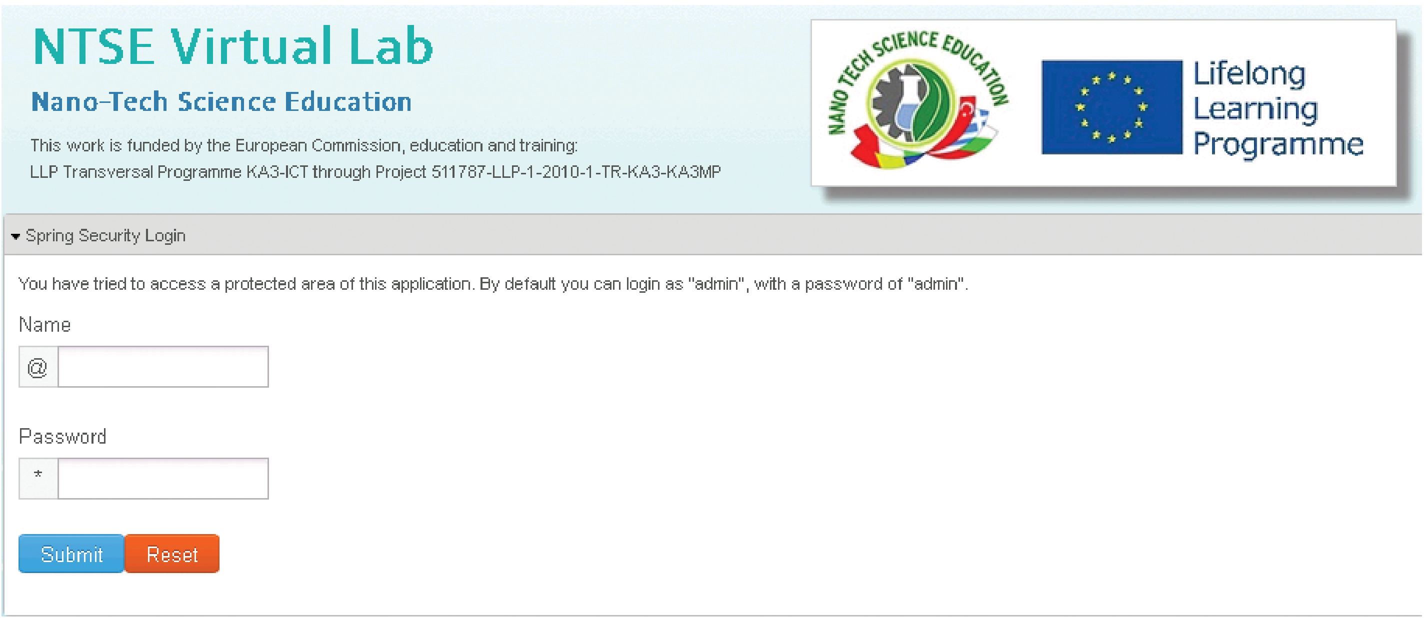




9. Help – contains a short demo video on how to use the virtual lab.



10. Login section for admin panel of the Virtual Lab – this panel is for managing or editing of all Virtual Lab functionalities by the partners.



II.2. Experiments Room

The Experiments Room creates a user-friendly virtual learning area to raise interest in science and Nanotechnology for different target groups as science teachers, prospective teachers (university students at science education faculties) and students aged 13-18 from general and vocational high schools. The Experiment Room promotes inquiry-based methods encouraging learners to think about phenomena by posing questions connected to real life.

The main aim of the Experiment Room is to create authentic experiments, support them with videos and simulations and add lesson plans to make them simpler and more interesting for all users.

The Experiment Room comprises nine authentic experiments with teacher and student guides, movies, simulations, assessment grids and other documents on the experiments.

These nine authentic experiments are Understanding Nanoscale, Making Origami Buckyball, Nanocrystal Fabrication, Lotus Effect, Iron Nanoparticles and Ferrofluids, Waves and Dancing Ferrofluid,LEDs,Carbon Nanotubes,Waveguide Fabrication by Sol-Gel.

The experiments and all educational documents in the Experiment Room comply with the requirements of school education and are matched to the curriculum. The chosen nine authentic experiments and educational tools are chose through various processes:

- Highly rated topics related to Nanotechnology were chosen from the questionnaire data collected from students, teachers and prospective teachers.
- Chosen topics about Nanotechnology were matched to the curriculum and high-rating topics valid for each partner's curriculum were defined.
- The grades of students and the lessons matching Nanotechnology topics, were determined to create the applicable educational tools in school education.
- Experiments were supported with movies, simulations and guides to make them visible and understandable for students, teachers and prospective teachers.

The Experiment Room contains nine authentic experiments and each experiment is composed of six sections:

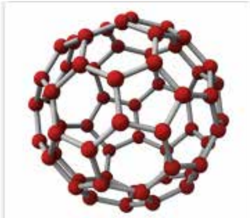
1. Movies: Videos of experiment shot by our team.
2. Interactions: Simulations related to the experiment.
3. Documents: Guides for students and teachers, assessment grids and experimental procedure.
4. Repository: Links and documents related to the experiment.
5. Other: Some other supporting documents for users.
6. Feedback: Interactive area for users to submit their comments.

II.2.1 General Information about Experiments in the Experiment Room

1.Understanding Nanoscale

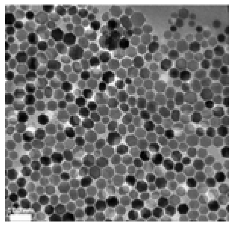
We do not see objects or measure distances in the nanoscale in our daily life. Therefore, comprehension of the nanoscale is realised by fun examples relating to nanoscale.

2.Making Origami Buckyball



This is a hands-on implementation involving students constructing a 3D model of a buckyball by using three sheets of paper, ruler, pencil and scissors.

3.Nanocrystal Fabrication

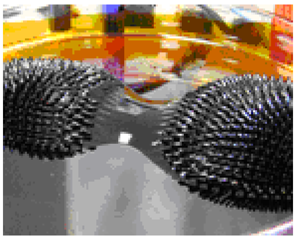


One of the simplest (and also industrially used) ways of nanocrystal fabrication is uncovered and explained in detail.

4.Lotus Effect

This experiment gives an example of Nanotechnology from nature by using the super hydrophobic behaviour of the lotus plant.

5. Iron Nanoparticules and Ferrofluids

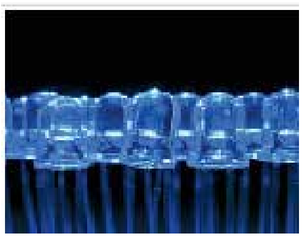


This experiment is about the application of a nanoproduct, ferrofluids, revealing the difference between Nanotechnology (and properties of nanoproducts) and conventional technologies.

6. Waves and Dancing Ferrofluid

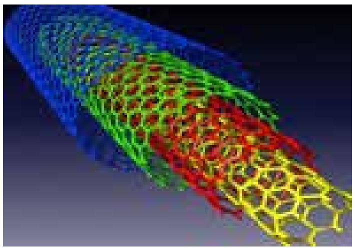
This experiment is aimed to provide an understanding of how the particles act in changing magnetic field. If there is no magnetic field, ferromagnetic nanoparticles are random, otherwise ferrofluids are regular.

7. LEDs (Light Emitting Diodes)



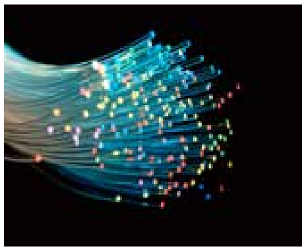
This experiment explores the physical phenomenon of LEDs, how they operate, their unique features, together with the characteristics of light. LEDs are environmentally friendly, ultra-efficient electronic (or semiconductor) lighting devices that emit cooler, softer and/or more natural light with relatively the least consumption of watts when electrical current passes through them.

8. Carbon Nanotubes



The carbon atom seems to be the most wonderful of all the elements in the periodic table. As well as being the basis of life, it is one of the most important building blocks of nanotechnology. Carbon nanotubes, composed of interlocking carbon atoms, are 1000 times thinner than human hair and can be 100 times stronger than steel. The amazing properties of carbon nanotubes provide many application areas.

9. Waveguide Fabrication by Sol-Gel



This experiment is aimed to provide an understanding of sol-gel, its products, including fiber optics used in the internet communication. Fiber Optics is a data-delivery system transmitting light and sound through glass fibers. In telecommunications, the fiber optic technology has replaced the copper-wire technology by delivering information 1000 times faster and 100 times farther.

Let's visit one of the experiments in the Virtual Lab Experiment Room!

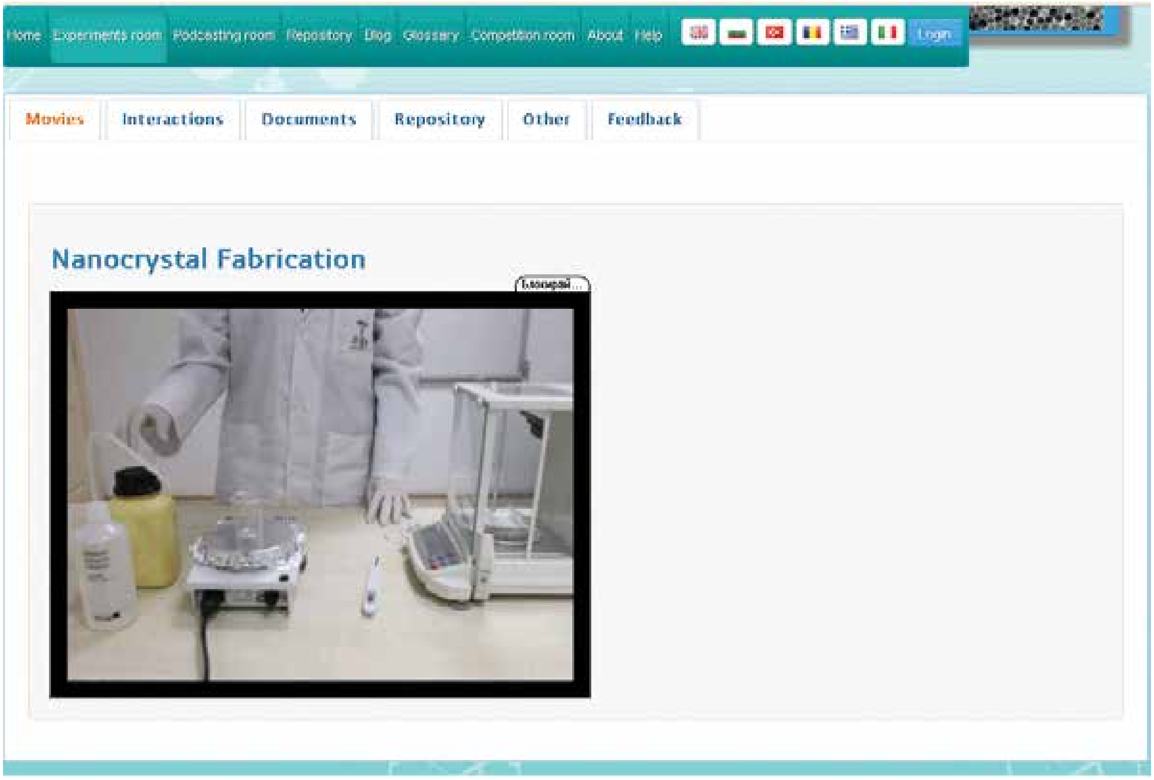
II.2.2 Nanocrystal Fabrication

Research on nanocrystalline materials has increased enormously during the past years. These intense investigations have been stimulated by several envisaged application areas for this new class of materials. In this section, one of the simplest methods of nanocrystal fabrication is shown and explained in detail .

Components of Nanocrystal Fabrication Experiment

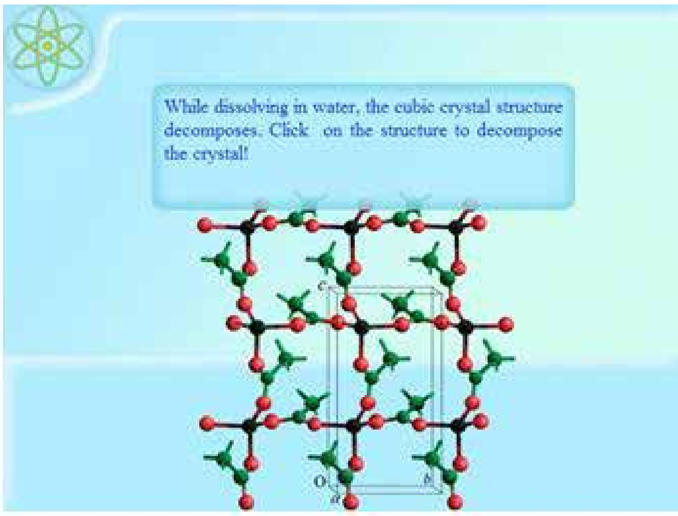
Movie

An experiment is being performed by an expert with simple school materials. This is a demonstration experiment in which the teacher is performing and students are watching. The experiment is about nanocrystal fabrication by precipitation from solution. It happens in two steps: 1. Solution formation, 2.Precipitation from the solution. Some nanocrystals are produced via this method in industry.



Interactions (Simulations)

There are four simulations that show details of the nanocrystal fabrication experiment.



Dissolution: Simulation of the first step of experiment. Formation of the solution is explained.

Molecular dissolution: Formation of the solution is explained at the molecular level, which cannot be seen with the naked eye.

Precipitation: Simulation of the second step of the experiment. Precipitation of the solution is explained.

Molecular Precipitation: Precipitation of the solution is explained at the molecular level, which cannot be seen with the naked eye.

Documents

There are four different kinds of documents here that enlighten teachers and students about the content.

1. Procedure: How to perform the experiment is explained step-by-step.
2. Students Guide: Contains effective and simple daily life examples about nanocrystals and some games for the classroom to help understand nanocrystals in an enjoyable way.
3. Teachers Guide: Contains detailed information and a lesson plan about nanocrystals for teachers. Objectives of teaching nanocrystals and teaching techniques are explained in the lesson plan.
4. Assessment Grids: Contains a scale for self-assessment of students. Students can assess and evaluate themselves on the topic of nanocrystals via this grid.

Repository

There are two documents in this section. One is a video about the experience of a master's student about nanomaterials and the other is an eBook about micro and nano-transport of bio-molecules. Both documents provide interesting additional information to the users.

Other

There are two PowerPoint documents about solid structures and nanocrystals to provide information in an interactive way. Both educational documents are prepared by teachers to inform students about content.

Feedback

This section is prepared for users to write their ideas, ask questions and make requests about the content.

II.3. Podcasting

As is known, the podcasting feature involves a kind of digital media containing short series of audio, video, documents or e-published files subscribed to and downloaded or streamed online via a computer or mobile device.

The Virtual Laboratory Podcasting section includes various clips related to selected aspects of some scientists' careers, the importance of female scientists in the actual research world, main parts of the nano-lessons that involved 7th and 11th grade students, considerations concerning the implication of the students in several nano-activities, as well as parts of videoconferences organised within the framework of the project.

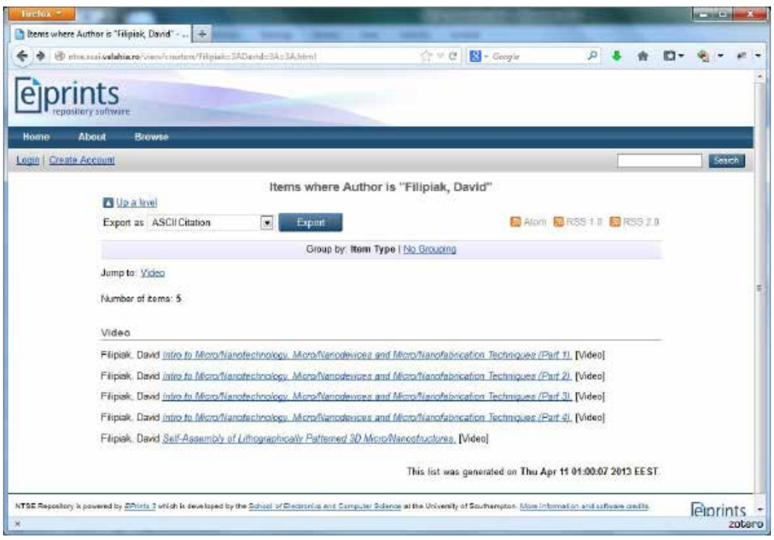
II.4. Repository

The Virtual Laboratory Repository (direct access: http://ntse.ssai.valahia.ro) has been conceived as a database that includes extra readings and references related to Nanotechnology. It has special sections that contain articles, books, chapters, posters, video clips, experiments and methodological documents. All the resources are useful for students and prospective / in-service teachers, who can exploit them as educational materials. In addition, the Repository fulfils the role of updating Virtual Laboratory users' knowledge and providing a package of educational materials, with the aim of increasing the reader's interest in Nanotechnology.

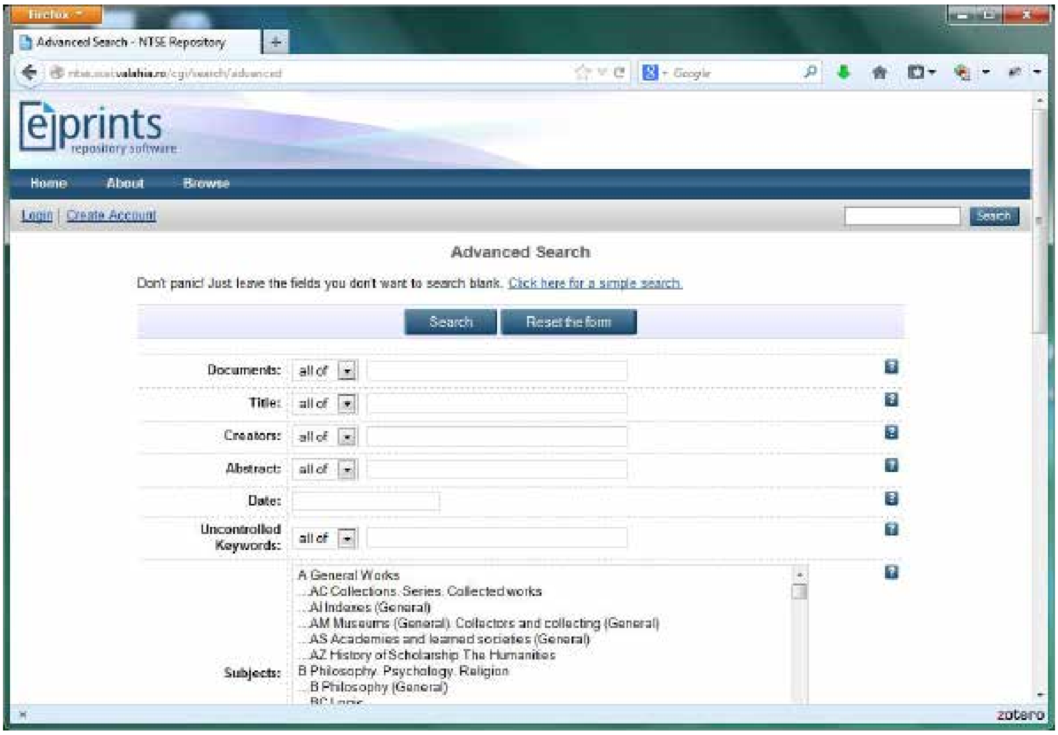
The solution adopted for designing the Repository is based on the EPrints application: a free professional software platform for constructing a good Open Archives Initiative repository.

The Repository interface offers users services such as: repository browsing, a search tool, list of latest added items, etc. Users have to be registered, following the "Create Account" button steps. After that, the user can edit their own profile by typing in their organization name, department, home page URL and other information. After the login process, a list with the items uploaded by the user can be browsed. All items uploaded in the repository can be retrieved by year, subject and author, using the "Browse" menu (Gorghiu et al., 2013).

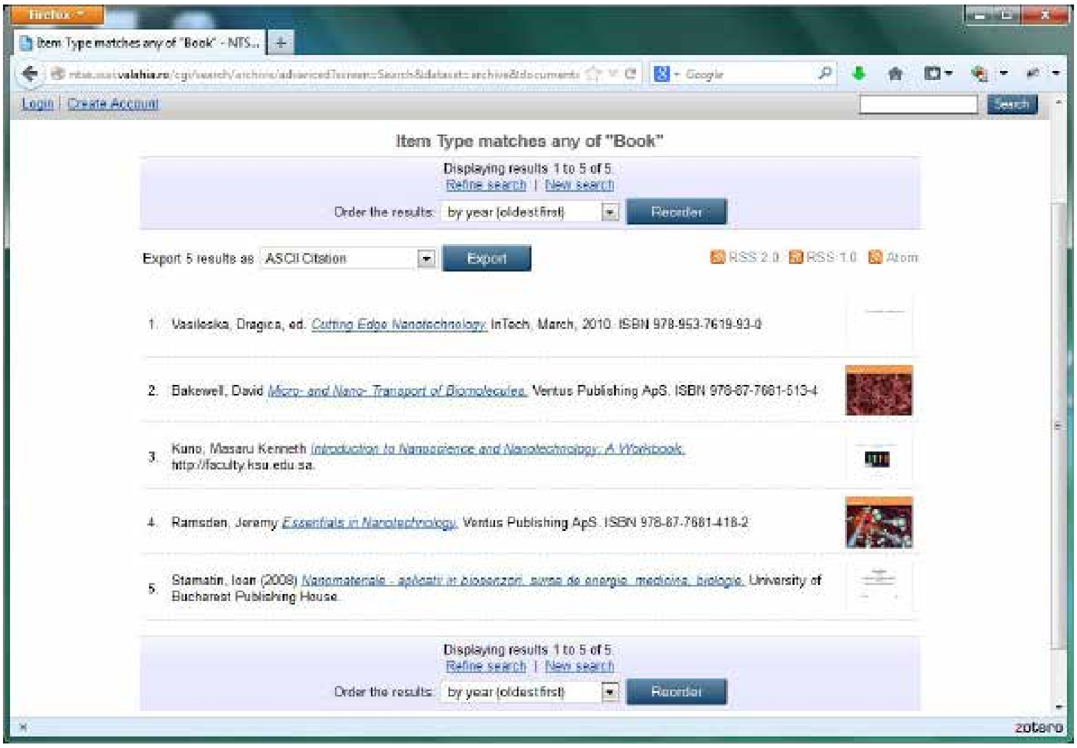
The list of illustrated subjects is predefined and follows the Library of Congress Classification, where the sub-categories are automatically generated when an item is linked to a specific subject.



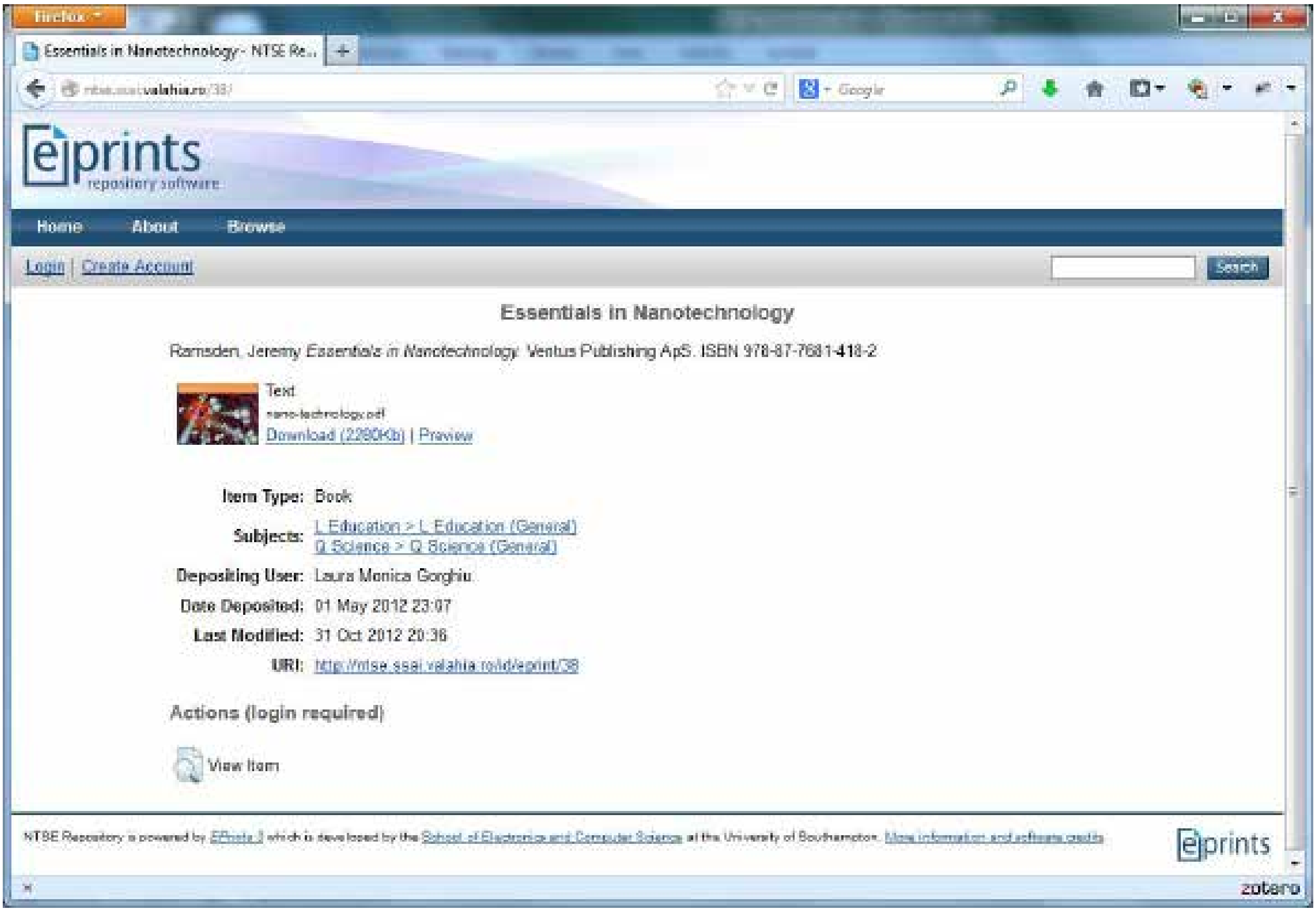
The search tool can be used for a simple or advanced search. The advanced search allows the introduction of related criteria in a specific web form. The search can be performed taking into consideration specific metadata fields: document terms, titles, creators, subjects, item type, editors, item status, etc.

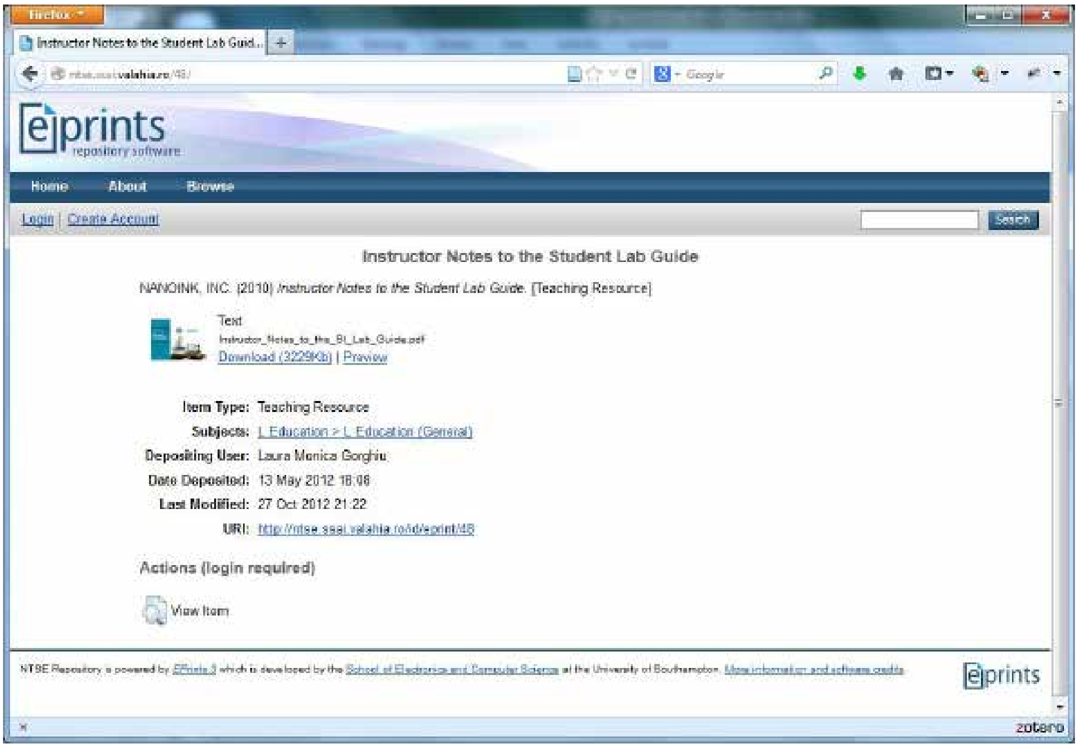


Besides videos, conference articles or books, teaching resources can be also retrieved in the Repository.



Information related to a specific object is available by clicking on it.





Besides videos, conference articles or books, teaching resources can be also retrieved in the Repository.

II.5. Glossary

The Virtual Laboratory Glossary has a specific purpose and usage. It contains the meaning of vocabulary in the texts of teacher and student guidelines in the Experiments Room of the Virtual Laboratory. While preparing this text, authors, focused on the technical and scientific concepts in the guidelines so that students could make out information about the subjects they don't know or remember. The use of the glossary is easy as it is listed alphabetically. The list of terms contained in the glossary helps familiarise readers with uncommon words. The words in the glossary are updated periodically when the guidelines in the experiments room enriched with the experiments.

II.6. Demo

The Virtual Laboratory Demo contains all the support videos prepared as deliverables related to the Virtual Lab. It presents a demo guided tour, as well as a teacher guided tour.

The Demo can be accessed at: **http://vlab.ntse-nanotech.eu/NanoVirtualLab/helpentitys/help.**

II.7. Blog

As is known, blogs are informational and/or discussion sites online and which contain posts shown in a reverse chronological order.

The Virtual laboratory Blog (http://ntse.iacm.forth.gr/index.php/en/) includes several nano-topics organised in specific categories, with an important feed of information related to nano-news that can be commented on and discussed.

III. Educational Practices for Target Groups

III.1. Secondary Students and Vocational School Students

How can a Lesson Plan with Virtual Laboratory components be implemented?

Before the implementation, examining the Guideline Book and the Guided Tour will provide a good reference for users. The Guideline Book provides the user with a broad overview to help understand the main concepts and the aim of the Virtual Lab and the Nanotech Science Education-NTSE Project.

The Guided Tour is a simulation, guiding the users step-by-step in using the Virtual Laboratory. In this context, the users are able to find their way around using the Experiment Room and its tools.

Teachers Guidelines, Students Guidelines, Experiment Videos, Simulations (if available), Assessment Grids, Procedures, Repository and other uploaded documents are designed to help users to integrate their chosen Nanotechnology topics to integrate with their curriculum and real life.

The Lesson Plans can be implemented by the users in three ways:

1. Classroom Implementations

A teacher can implement certain lesson plans in a classroom setting.

Teachers can use the following materials to integrate Nanotechnology lesson plans with the science curriculum and to reconcile them with real life:

- Guidelines
- Students Guidelines
- Experiment Videos
- Simulations
- Other materials for the use of teachers and students to raise their awareness in Nanotechnology.

The inquiry-based guidelines include activities that help users to understand the scientific facts and processes of real-life phenomena.

In order to implement the lesson plans, the Guideline Book and Guided Tour are provided to help teachers to experience the Teachers Guidelines in collaboration with the Students Guidelines, Experiment Videos, simulations and other documents provided in the Experiment Room.

Before classroom implementations, teachers read the “Foreword for Teachers” stage in the Teachers Guideline, which is provided especially for them as a preliminary knowledge and initiates the lesson with its “Introduction” stage. By following the instructions step-by-step as shown in the Teachers Guideline, teachers are able to implement the lesson plans in their classrooms.


Classroom Implementation of “Making Origami Buckyball” Experiment at Çekirge Doğa High School, Turkey


Classroom Implementation of “Nano Crystal fabrication” Experiment at Bostancı Doğa High School, Turkey

2. Self-Implementation

Users can implement the lesson plans at home individually. The Guided Tour is a well-instructed simulation for users, explaining the implementation step-by-step according to the Teachers and Students Guidelines, and is to be used collaboratively with Experiment videos, simulations and other documents provided in the Experiment Room.

3. Videoconference Sessions

Videoconference sessions are planned between at least two schools with similar profiles (two remote locations).

Videoconference session between Acarkent Doğa High School / TR and John Atasanov High School / BG related to the “Nanocrystal Fabrication” Experiment

Videoconferences can be initiated in the some of the following setups:
- Classroom - Classroom
- Classroom - Laboratory
- Classroom - Expert
- Any two or more locations that are interested in same / similar topic

Three concepts of video sessions are available:

- Nano-Tech Lesson Plan (classroom - laboratory, classroom - classroom or classroom - expert): participating schools and a moderator are connected online via any videoconference tool (e.g. Adobe Connect, Skype, Gtalk, etc.). The aim of the video session is to implement an activity from the chosen nano-experiment. Students of participant schools make the activities at the same time with the instructions given by the moderator. After the activity is done they share their experience and conclusions.

Tip: It is a good idea to have the video connection just at the beginning and end of a lesson – there is no need to keep it for the whole period.

- Quiz Show (classroom - classroom): Students participating in the videoconference session answer questions about the selected nano-experiment / topic to get higher scores.

Tip: Questions should be prepared in advance; if teachers or students come up with questions at the very moment, be sure to give them in written form, since language can be a barrier.

Tip: it is not necessary to have a winning and losing team; the prize should be related to watching a video or gaining extra knowledge or performing an experiment. It is not the Olympics, after all!

- Question and Answer (classroom - expert): Participating schools are connected to one of the project experts in order to ask their own questions and gain further information about the selected nano-topic.

Here are some instructions for planning and hosting a videoconference session / interactive videoconference:

1. Teachers meeting: teachers first have to exchange information by e-mail or web conference (e.g. Skype connection). For this to happen, all the participants should fill out the table below:

Name	Subject	Work Language	Topic	Mail / Skype / Other

3. Exchange information about students: be sure to tell your videoconference partner more about your group or yourself - how old are the participants, what are their interests, language level, knowledge, etc. This is very helpful for any videoconference companion!
4. Tools or what you need for a videoconference:

- a computer with Internet connection;
- software to connect to national / international partners (like Ovoo, Skype, VZO as open-source soft ware, or PVX Polycom and Adobe Bridge);
- an interactive whiteboard (IWB) - check how it works online;
- a webcam, best is a rotating camera or a camera on a tripod, connected to a PC;
- a camcorder and /or a camera to document your lesson.

5. List of topics: to start this way of teaching, you can take your inspiration from the materials presented in these guidelines!
6. Test videoconference: it is better to avoid mistakes by testing the connection between partners before the date fixed for the interactive session. You have to check technical equipment and any materials to be uploaded as part of the lesson plan.
7. Starting web/videoconference:

- connect camera and IWB to the computer
- open connection software

8. Web/videoconference - Steps:

- teachers introduce themselves;
- students introduce themselves to make them feel involved in activities (if your lesson will not last more than one hour, you can introduce the students by name alone);
- one of the partners starts the activity (or introduces the activity done before in the case of activities that need to been performed outside the classroom) interacting with the other partner by using slides or pictures;
- ask the students questions to be sure they are always involved in the lesson;
- give students some written tasks to make them check all their tasks and the activities to be done.

9. Revision & Documentation: it is very important to revise all the activities performed, and to make students reflect on the activities. Teachers explain the findings and point out any strengths or weaknesses... To spread good practice and make students work with a scientific methodology is very useful to prepare a report of the interactive session (video, presentation, gallery).

4. School and Laboratory Visits

Our real nano-bio technology laboratory in Istanbul, Turkey, is available for students and teachers. It is possible to visit the clean room and ask questions to our academics and project experts on Nanotechnology and its current implementations. In addition to this, our project experts visit schools to disseminate the project outcomes via the NTSE Project Virtual Laboratory.

They also implement the hands-on activities with nano kits to make science education more concrete and enjoyable for students. These workshops reinforce meaningful learning through actively involving students in the learning process.

The presentation of the NTSE Virtual Lab and nano-kit implementation at 30 Agustos Vocational School for Girls

The Nano-Bio Technology Laboratory visit of Hacı Rahime Ulusoy Maritime Technical and Vocational High School in March 2013

Vocational High School Students visited the Clean Room at the Nano- Bio Technology Laboratory in Doga Schools , Turkey

III.2. University Students and Prospective Science Teachers

How can an activity using Virtual Laboratory resources be mixed with other nano-web resources, and implemented in students and prospective science teachers' usual practice?

Most of the information in the different sections of the Virtual Lab can be used not only by students from secondary schools and teachers, but also by students involved in different bachelor or master's degree programs in the areas of science or technology. Since some of those students have to follow different courses and laboratories related to Nanoscience or Nanotechnology during the academic learning program, the information included in the "Experiments Room" can provide to the students with basic and advanced approaches to the Nano area in terms of:

- Learning about nanoscale terms and concepts:
  http://vlab.ntsenanotech.eu/NanoVirtualLab/experimentroom/908f4cedc98349d0b57e781ae3ea29c4
- Learning about crystal and nanocrystal structure:
  http://vlab.ntse-nanotech.eu/NanoVirtualLab/experimentroom/908f4cedc98349d0b57e781ae3ea29c1
- Learning about the process of obtaining nanoparticles:
  http://vlab.ntse-nanotech.eu/NanoVirtualLab/experimentroom/908f4cedc98349d0b57e781ae3ea29c5
- To learn about the way today's technology works;
- To link science lessons with the process of obtaining nanoparticles / nanocrystals;
- To learn the usage areas of nanotechnology in the context of nanoparticles;
- To design their own lesson plans in the nano area field

In the following paragraphs, some examples are given of how to use the different facilities of the Virtual Laboratory and how the information placed in the different rooms of the lab have been used by combining it with other information presented in other websites from the Internet, in order to develop students' basic approach to nano-matters.

During the proposed Lab meeting entitled "Nanoparticles size" the following information can be introduced and discussed with the students:

What is "nano"? Well, without providing a definite answer to this question, nano is a popular (emerging) area of science and technology today. It has attracted the attention of researchers from all walks of life, from physics to chemistry to biology and engineering.

In today's scientific realm, the word nano describes physical lengthscales that are on the order of a billionth of a metre long. Nanoscale materials therefore lie in a physical size regime between bulk, macroscale, materials (the realm of condensed matter physics) and molecular compounds (the realm of traditional chemistry).

In this respect, nanoscale physics, chemistry, biology and engineering asks basic, yet unanswered, questions such as how the optical and electrical properties of a given material evolve from those of individual atoms or molecules to those of the parent bulk. Other questions that nanoscience asks include:

- How does one make a nanometre-sized object?
- How do you make many (identical) nanometre-sized objects?
- How do the optical and electrical properties of this nanoscale object change with size?
- How does its optical and electrical properties change with its "dimensionality"?
- How do charges behave in nanoscale objects?
- How does charge transport occur in these materials?
- Do these nanoscale materials possess new and previously undiscovered properties?
- Are they useful?

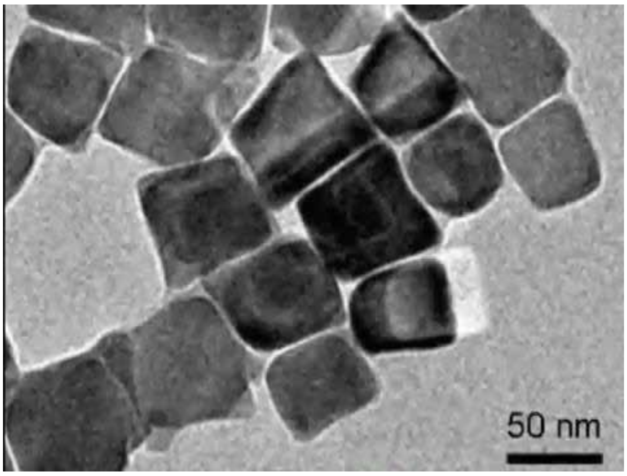
What are the relevant length scales for nano? Well, I guess it depends on who you talk to. On one hand some people call nano anything smaller than stuff on the micro level. This could mean dealing with stuff on the hundreds of nm scale. One useful perspective on a definition for the appropriate lengths scales for nano is a regime where the chemical, physical, optical and electrical properties of matter all become size and shape dependent.

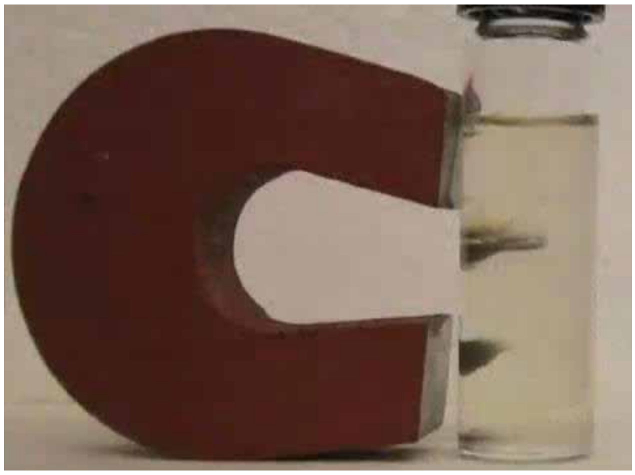
Resource proposed to be used (from Repository):

http://ntse.ssai.valahia.ro/35/1/Introduction_to_Nanoscience_and_Nanotechnology_By_Masaru-Kuno_1.pdf

When different nano-particles properties have to be discussed in relation of the structure compounds, the materials presented in the Experiment Room related to "Obtaining of magnetite nano particles" can be easily used.

For example, the short movie file entitled How to make magnetite nanoparticles in your kitchen (also from Repository: **http://ntse.ssai.valahia.ro/71/1/Nanorust%20Lab.mp4)** can be presented to the students at the beginning of the lab, together with the video-clip entitled Iron nanoparticles and Ferrofluids (from the Experiment Room of NTSE Virtual Lab: **http://vlab.ntse-nanotech.eu/NanoVirtualLab/experimentroom/908f4cedc98349d0b57e781ae3ea29c5).**





On the base of the presented information, the following discussion can be made with students:

Magnetite has an inverse spinel structure with oxygen forming a face-centred cubic crystal system. In magnetite, all tetrahedral sites are occupied by Fe^{3+} and octahedral sites are occupied by both Fe^{3+} and Fe^{2+}. Maghemite differs from magnetite in that all or most of the iron is in the trivalent state (Fe^{3+}) and by the presence of cation vacancies in the octahedral sites. Maghemite has a cubic unit cell in which each cell contains 32 O ions, 21.⅓ Fe^{3+} ions and 2.⅔ vacancies. The cations are distributed randomly over the 8 tetrahedral and 16 octahedral sites.

Iron oxide nano-particles are iron oxide particles with diameters between about 1 and 100 nanometres. The two main forms are magnetite (Fe_3O_4) and its oxidised form maghemite (Fe_2O_3). They have attracted extensive interest due to their superparamagnetic properties and their potential applications in many fields (although Cu, Co and Ni are also highly magnetic materials, they are toxic and easily oxidised).

Applications of iron oxide nano-particles include terabit magnetic storage devices, catalysis, sensors, and high-sensitivity biomolecular magnetic resonance imaging (MRI) for medical diagnosis and therapeutics. These applications require coating of the nanoparticles by agents such as long-chain fatty acids, alkyl-substituted amines and diols. Additional proposed Resource (from Internet): http://en.wikipedia.org/wiki/Iron_oxide_nanoparticles

After the discussion related to the structure of magnetite nanoparticles, the students can be invited to obtain such kind of nanoparticles by following the next procedure:

Materials and ingredients: vegetable oil, acetic acid 5%, solid sodium hydroxide, water, rust (rust consists of hydrated iron (III) oxide $Fe_2O_3 \cdot nH_2O$ and iron (III) oxide-hydroxide $FeO(OH) \cdot Fe(OH)_3$), heater / stirrer apparatus, crystalliser, Erlemayer glasses.

Procedure:

• Add 50 ml vegetable oil in an Erlenmayer glass;

• Prepare a sodium hydroxide solution by dissolving 7,5 g of solid NaOH in 30 ml of water;

• Put the glass with oil under the stirrer and add gently the NaOH solution and keep it under continue stirring about 15 min;

• The obtained mixture will be transferred into a crystalliser for about 2 days until a solid mass will be obtained (soap).

• Add 300 ml acetic acid over the soap and dissolve it under low heating by continue stirring (15-30 min); it can be observed two distinct layers have occur after complete dissolution – using a separating funnel place the upper layer into a clean glass;

• Keep under medium heat the separated upper layer about 30 min until a yellow and clear liquid mixture is obtained (fatty acid mixture);

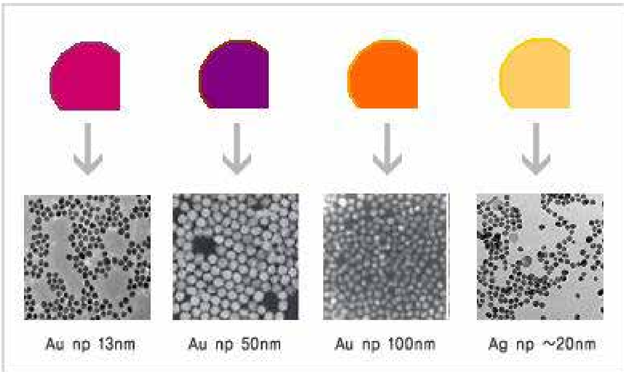
• Add 5 g of rust and keep stirring under medium to low heat about 10 min;

• Cover the glass and keep at low heating about 1,5-2 hours until stops the vapour release

• Dry the solid mass obtained (magnetite nanoparticles 50-90 nanometres) and observe the particles at the microscope.

In another Lab meeting, focused on Colloidal synthesis of nanoparticles the students should be asked to read the information presented in the following next web-sites, being asked to see the difference of the properties, function of nanoparticles' dimensions:

- **http://www.nanoblog.ch/uploads/file/o2904_09-03-23-topic-1-parak.pdf**
- **http://www.google.ro/url?sa=i&rct=j&q=colloidal+synthesis+of+nanoparticles&source=images&cd=&cad=rja&docid=GdHfaqSlm4r4lM&tbnid=5qOvuUfyoYSubM:&ved=0CAMQjhw&url=http%3A%2F%2Fwww.springerimages.com%2FImages%2FRSS%2F1-10.1007_s11244-007-9028-1-5&ei=mJteUbz9AYbfswav5YGwCQ&psig=AFQjCNGqRPuQvrRRrmY3J1YQFThtEdO7fw&ust=1365241108683304**
- **http://www.docstoc.com/docs/41764728/Colloidal-Synthesis-and-Characterization-of-ZnO-and-ZnS-Nanoparticles**
- **http://www.docstoc.com/docs/22838211/Synthesis-and-Study-of-Silver-Nanoparticles**
- **http://www.sciencedirect.com/science/article/pii/S0021979711014585**



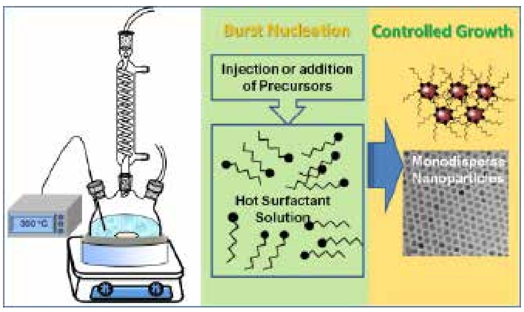
At the same time, the students are invited to read and debate about Nanofluids, using the resource included in the Repository: http://ntse.ssai.valahia.ro/36/1/Cutting%20Edge%20Nanotechnology.pdf (starting from page 251).

Then, an academic discourse can be organised during the meeting where the following information is presented and discussed.

Colloidal synthetic approaches have provided versatile tools for constructing uniform nanomaterials with controlled size, shape and crystalline phase. A variety of methods have been utilised to produce nanoparticles including milling, vapour-phase deposition techniques and solution-based synthesis. This section will be focused on colloidal solution-based methods as it is more commonly used in catalytic studies.

General colloidal synthesis primarily consists of three components: reactive precursors for particle formation, surfactants to direct particle size and shape, and solvents to act as a reaction medium. The choice of precursors, surfactants and solvents depend on the material and morphology desired. Typical reaction pathways include thermal decomposition, chemical reduction or oxidation, precipitation, sol–gel and galvanic exchange/replacement.

For metal nanoparticles, thermal decomposition is often chosen because it can produce small, spherical particles that are monodisperse, having size distributions within 5% (gr ≤ 5%). Precursors consist of zero-valent organometallics that are rapidly injected into hot high-boiling solvents with stabilizing surfactants. These reactions are often conducted using standard air-free techniques, as many of the precursors typically used are toxic and/or pyrophoric. Thermal reactions are often conducted at temperatures between 120 °C and 300 °C. The following figure shows a typical reaction setup consisting of a stir-bar, stir plate, heating mantle or oil bath, 3-neck round bottom flask fitted with a septum for injections, a thermocouple and a reflux condenser affixed to an inert gas line and bubbler.

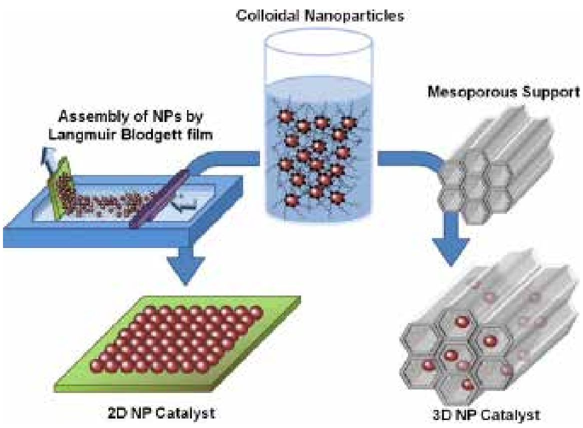


A typical reaction setup and concept for colloidal synthesis of nanoparticles.

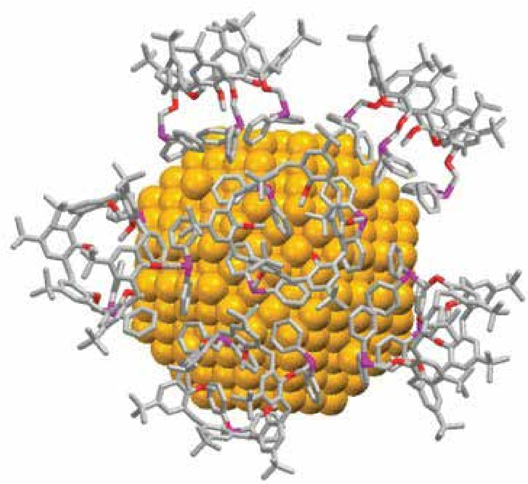
Many metal chalcogenides are also made similarly with either the chalcogenide or metal precursor pre-dissolved in the reaction solution before injection. When using ionic precursors, reducing agents may also be needed to produce zero-valent metals or alloys. This allows for the formation of nanoparticles at ambient temperatures or in aqueous solutions. For slow growth, mild reducing agents are used, such as carboxylic acids or thermally activated 1,2-alkanediols. Stronger reducing agents, such as sodium borohydride or superhydride, are required for fast nucleation processes or for metal complexes with very negative reduction potentials.

Then the students would be invited to read and discuss the preparation of 2-D and 3-D nanocatalysts.

Colloidal metal nanoparticles can be applied to two types of catalysts; 2-dimensional (2-D) and 3-dimensional (3-D) catalysts. For decades, single crystals have been used for model studies of surfaces and catalysis, both as metal films and supports for metal particles. Similarly, 2-D catalysts are prepared by self-assembled nanoparticles deposited on a substrate by using the Langmuir–Blodgett technique (presented in the next). Surfactant stabilised colloidal nanoparticles floated on poor solvent – like water for the case of hydrophobic particles – then, assembled to form a closed packed array and deposited on a substrate by immersing the substrate form the liquid.



Schematic illustrations for preparation of colloidal nanoparticle-based 2-D and 3-D catalysts



Conventional industrial catalysts are composed of metal nanoparticles supported on the high surface materials. In order to prepare for industrial heterogeneous catalysts with high surface area, two kinds of methods are mainly adopted: ion-exchange and incipient wetness. In both cases, active metal nanoparticles with a size range of 1–10 nm are deposited on and into metal oxides or carbons with high surface area. For ion-exchange, electrostatic interactions between metal precursor and support guarantee high dispersion of nanopaticles, whereas the incipient wetness provides a simple way to obtain nanoparticle catalysts in a large scale by using capillary force to load metal precursors in solution. However, both methods have a broad size distribution of nanoparticles, because of difficulties controlling thermal activation and reduction during the formation of particles on the supports.

Organizing a Virtual Lab meeting dedicated to Synthesis of nanomaterials, the information found in the Experiment Room of the Virtual Laboratory concerning the above-mentioned topic should be combined with the additional information from the following website, which can be introduced to the students: **http://nanoall.blogspot.ro/2012/01/synthesis-of-nanomaterials.html.** The synthesis approaches should be then discussed.

Going deeper into the topic Synthesis of metallic nanoparticles supplementary information can be introduced to the students **(http://nanoall.blogspot.ro/2012/01/synthesis-of-metallic-nanoparticles.html)** and then the function of the experimental basis and the synthesis of different metallic nanoparticles can be introduced.

III.3. Science Teachers

How can a Virtual Laboratory resource be implemented by Science teachers?

As a first recommendation we would encourage teachers to exploit as much as possible the widespread educational materials provided by NTSE's Virtual Lab, in order to implement an effective lesson plan with their pupils, even when it's impossible to reproduce the real proposed experiments.

Although in some cases the proposed practical experience is not a real experiment, it however represents a tool aimed at better understanding the related scientific concept. For instance, even if the lesson plan "Making Origami Buckyball" suggests as a practical experience just the realization of a macroscopic level model of this molecular structure, it in fact represents an effective aid to better illustrate carbon's bonding ability.

As can be seen, each of the lesson plans proposes different educational tools (Movies, Interactions, Documents, Repository, Other, Feedback) on their own pages.

Now we want to focus your attention on the Interactions Room where there some applets are available reproducing the different steps of the whole experiment. Accordingly, if the class will not reproduce the real experiment, those simulations should be watched in order to allow the students to better assimilate the crucial concepts of the experience.

Using, for instance, the lesson plan "Nanocrystals fabrication," it is possible to have an overview of the procedure to implement a lesson plan exploiting all the kinds of educational tools available in the page. As already recommended in the Educational Practices for Students (see paragraphs III.1.), first the teachers should read the guide available in the room "Documents." In the guide, after the foreword for the teacher, there are some suggestions about how to introduce the subjects with students at an early stage. In particular the proposed questions focus the attention on such topics like dissolution of compounds and the visibility of things related to their dimension, leading the students to topics already dealt with in curricular programs in Chemistry and Physics. Then teachers could invite the students to investigate the subject by themselves –individually or collaboratively – reading the Student Guidelines and watching the multimedia resources available in the Repository room.

The following phase envisages the experiments that could be performed in different ways exploiting the laboratorial procedures, the videos and the applets available in the Interactions room. The best way could be to carry out the real experiment integrated by the video and the applets, and if possible the class should be split in small groups of 4-5 pupils and each group should be equipped to carry out the whole experiment. If a school has no laboratory, the exploitation of solely virtual resources could result in effective educational outcomes. In this case it could also be better to split the class into small groups and have each of them carry out their own research work.

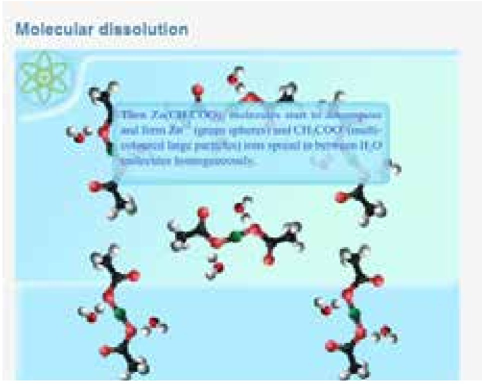
The video available in the experiment room "Nanocrystals Fabrication" shows the right procedure for the real experiment performed by an expert in a laboratory. It's important to notice that the expert adopts all the precautions needed to operate in a chemical laboratory correctly. The video could be watched by the class before the students accomplish the real experiment.

The applets simulating the experiment could be used while the real experiment is on stage. In the case of "Nanocrystals Fabrication" the whole procedure has been split into four parts to better lead the users through the different steps of the experience:

1. Dissolution - besides illustrating the right procedure for the first step of the experiment, the phenomena displayed in this first applet can be related to the curricular programs in Chemistry when we talk about solutions;

Snapshots from the video available in the "Nanocrystals Fabrication" Movies room (left) and from the Applet 1 (right), showing the first steps of the experimental procedure.

2. Molecular dissolution - this applet simulates in-depth the phenomena of dissolution by illustrating at a molecular level the decomposition of Zinc Acetate molecules in ZN2+ and CaC3COO- ions;

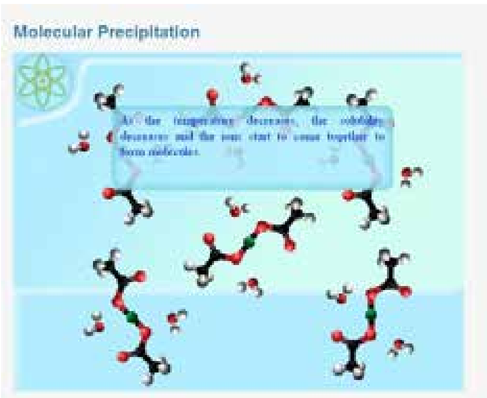


Snapshots from the video (left) illustrating the dissolution of Zinc Acetate in a macroscopic level and from the applet 2 (right) illustrating the same phenomena at a molecular level.

3. Precipitation - this applet illustrates at a macroscopic level the crucial phase of the experiment represented by the formation of nano-crystals of Zinc Acetate during the cooling of the solution. The attention of the students should be focused on the moment at which the precipitate becomes visible. The phenomena could be related to the relationship between the dimension of the new formed crystals and the wavelengths in the spectrum of light;

Snapshots from the video (left) and from the applet 3 (right) showing the moment when the new formed crystals become visible.

4. Molecular precipitation - this last applet simulates the development of the new crystal of Zinc Acetate at a molecular level.



Snapshot from the applet 4 showing the formation of the new formed crystals in a molecular level.

Considering that the execution of the different steps of the real experiment requires longer times than those shown in the virtual simulations, the different applets could be watched by the users during the waiting time (ethanol boiling, zinc acetate dissolution, precipitation, etc.) to anticipate the following steps or to discuss experiment so far.

Once the experiment has been carried out, the subjects it covered can be discussed and examined in depth exploiting the documents available in the Repository and Other rooms that provide further scientific information for the user (E.G.: Meijer, Janne Mieke Master Nanomaterials from a student's perspective. Video http://ntse.ssai.valahia.ro/54/; Bakewell, David Micro and Nano-Transport of Biomolecules. http://ntse.ssai.valahia.ro/39/)

In the Documents room a Self Assessment Grid for Student is available that should be completed by each student involved in the implementation. The outcomes resulting from the filled grids can be easily elaborated in order to gain feedback on the educational effectiveness of the lesson plan.

III.4. Other Target Groups

How can a Virtual Laboratory resource be used by other target groups (researchers, education stakeholders and academic staff)?

In education, research illustrates different ways in which scientific concepts are promoted and experimented (Galton and MacBeath, 2008). While laboratory work is generally considered the most common activity in science, students often find science boring, even though they prefer to work in groups (Pell et al., 2007). It is noticed that for productive group work equipment is not always needed, but engaging students in considering alternative ways of explaining events, planning investigations, or working out how to interpret data from others' experiments is very important (Crawford, 2000).

Having different digital tools as suitable examples designed for mathematics and science classes, it is evident that the introduction of information and communication technology in education led to improved learning results changes in practices, with a positive effect on learning (Lipponen, 1999). In this respect, ICT represents a proper channel to be used for developing knowledge acquisition, to change structures of classroom activities, to increase students' control over their own learning, and to enhance motivation in science classes.

When the topics presented during science lessons - such as those connected with the structure and properties of nanomaterials, or the connection between science and nanotechnology - could not be explained or emphasised by using real experiments due to the lack of materials/reagents at the teacher' disposal, NTSE Virtual Laboratory - including digital tools and learning science through ICT tools - can be a powerful instrument to introduce new steps made by researchers in Nanoscience and Nanotechnology products. If digital tools are fully exploited, they can offer innovation in teaching and also ways to increase the attractiveness of learning. It was clearly demonstrated that ICT facilitates wider access to innovative resources, regardless of geographical or socioeconomic barriers (Gorghiu & Gorghiu, 2013). In fact, ICT represents the core of a new paradigm of borderless education that is proposed to be implemented with the view of providing innovative ideas and even possibilities for reforming education in different parts of the world (Lubis et al., 2009).

The stakeholders from education have to be connected to new steps in science and technology, the ways in which ICT can help in emphasizing science and technology developments, and they have to promote the introduction of those novelties into the in-service teachers' training programs. With those programs science teachers should obtain the necessary knowledge related to the new development in science and be able to introduce in their lessons many more examples from these new findings in order to increase the students' motivation to learn and understand science. Nanoscience and Nanotechnology matters, by their incredible applications, offer many possibilities to emphasise to students how much science can offer us today and how much we can do if we are aware of these discoveries. But, on the other hand, due to the small dimensions of the particles involved in Nanoscience and Nanotechnology, not all teachers have the experimental basis to create and develop real experiments in the classroom. In this case, the use of virtual experiments remains the most important tool for emphasizing topics related to these fields. Promoting the NTSE Virtual Laboratory to the level of all educational stakeholders would lead to the use of the lab as an electronic platform in which they can find the collection of didactic materials that comprise virtual experiments, interactive simulations or multimedia products designed to attract the students to the science learning process. The materials and facilities of the Virtual Lab have been designed in such way that they can be used in different scopes by different kind of education stakeholders. We can give some examples of the use of NTSE Virtual lab by different kind of education stakeholders (students, teachers, academic staff, heads of schools, researchers, inspectors and policy makers).

The Virtual Laboratory Demo, prepared as a teacher' guided tour, can be used by academic staff in different seminars, workshops or in-service teacher training programs for introducing the possibilities offered by the new ICT tools in the process of explaining or practicing different science topics. On the other hand, this demo guided tour can also be used by science teachers when introducing the possibility of alternating real experiments with virtual ones in different lessons.

The Experiment Room of the VL can be also used by academic staff, pre-service and in-service teachers during training programs, where different experiments can be discussed and suitable possibilities of their implementation during science lessons should be emphasised. The advantage of the VL Experiment Room is that it offers materials prepared in different ways – from the text materials to interactive simulations and video clips. These materials can be used during the implementation of a certain topic into the classroom and can also be combined with the other materials included in other sections of the Virtual Lab.

Trying to raise the students' interest in science (in general), and Nanotechnology (in particular), a Podcasting Room was introduced to the Virtual Lab. But this room is not dedicated only to students from secondary schools. It is a powerful VL facility that should/can be used by different researchers to introduce their new scientific research findings at the educational level. Different short interviews can be made in order to promote the new materials obtained from scientific laboratories and their potential properties. In this way, researchers can become models for the pupils and students; the interviews can be very important for those students attracted to the area of science and who follow specific academic learning study programs (bachelor, master's degrees or even Ph.D.). In addition, the Podcasting Room can be also a good opportunity for researchers to hear about the new findings of other researchers and to connect with each other for future collaboration.

The broadcasting of photos from various conferences, seminars, workshops and interviews with successful women scientists, engineers and business men and women should be used by in-service teachers, head of schools, academic staff, researchers, inspectors or policy makers to promote all the activities developed by the science community in different countries. In this way, the Podcasting Room can become an up-to-date radiography of the science community activity.

At the beginning of designing the VL process, the NTSE partnership made a need analysis related to Nanotechnology knowledge in the partners' countries. At the end of analysis the team discovered that there are enough in-service teachers who say they lack knowledge on nanotechnology, and a certain part of prospective teachers interviewed in each country also declared that they only know what nanotechnology is, but do not have any further knowledge. Due to this finding, the NTSE partnership decided that the introduction of a resource library (NTSE e-Repository) in the Virtual Lab, with scientific and methodological articles, books, papers, posters, learning objects and news about the latest discoveries in the field, is imperative, to be consulted by both target groups. The resources included in the NTSE e-Repository have been completed with other multimedia products useful not only for teachers and prospective teachers, but also for students. The resources in the Repository are interesting not only for students from secondary education and teachers, but also for bachelor or master's degree students, since the level of some articles, books, papers or posters is enough to consider them scientific literature. In addition, researchers can find in the Repository information and findings related to certain topics considered interesting from their perspective. By contacting the NTSE team they can also introduce their scientific research to the Repository. Going through the information existent in the Repository materials, policy makers can obtain a real vision of the development of Nanoscience and Nanotechnology, and they can decide the ways to change the actual curricula in order to adapt it to new findings.

The Blog section organised in the Virtual Lab was introduced in order to ensure there was a place where every education stakeholder can not only read different news related to Nanoscience and Nanotechnology, but also to interact and introduce his/her experience or opinion on certain topics. The forum organised inside the Blog is a powerful opportunity to develop a community interested in those areas. By posting different information in the Nano-news, Nano-projects and Nano-links areas, the educational and research community can be up-to-date about the novelties in the above-mentioned domains.

The Glossary section of Virtual Lab is a facility that can be used by all types of education stakeholders, especially those less familiar with the specific terms used in science. It is a very important tool, especially for students involved in different science academic study programs who are preparing to become teachers or researchers.

The Competition room is a special section of the Virtual Lab that can be used by education stakeholders to promote Nanoscience and Nanotechnology to students. With the posters prepared by students from different countries in the Nano-competition the section can raise students' interest in the topics presented in the posters. The posters designed can be used as examples for future competitors, and through promoting activities made by different education stakeholders, new competitions can be organised in the future.

IV. Gender Equality

The EU is committed to sustain strategies for ensuring full participation and achievement in the sciences by women and girls. According to the report She Figures 2012: Gender in Research and Innovation, women are still underrepresented in both the public and private research sectors. (http://ec.europa.eu/research/sciencesociety/document_library/pdf_06/she-figures-2012_en.pdf)

Here are some of the findings of the survey in terms of scientific employment, scientific fields, career development and decision-making process of women:

In terms of scientific employment:

• On average in the EU-27, women represented 40 % of all researchers in the Higher Education Sector, 40 % in the Government Sector and 19 % in the Business Enterprise Sector, but in all three sectors the number of female researchers has been witnessing higher growth rates than the number of male researchers.

In terms of scientific fields:

• Over the period 2002–2009, female researchers were generally gaining ground in all fields of science in Higher Education, although at a very different pace in the different countries. Inparticular, the humanities as well as in engineering and technology; these fields were attracting more and more women. Contrary to the relatively uniform distribution of female researchers across science fields in Higher Education, the situation in the Government Sector is much more diverse and disparate, and the way the number of female researchers evolved over time in the different fields of science was highly country-specific.

In terms of career development:

• Women's academic career remains markedly characterised by strong vertical segregation. In 2010, the proportion of female students (55 %) and graduates (59 %) exceeded that of male students, but men outnumbered women among PhD students and graduates (the proportion of female students stood at 49 % and that of PhD graduates at 46 %). Furthermore, women represented only 44 % of grade C academic staff, 37 % of grade B academic staff and 20 % of grade A academic staff.

In terms of decision making:

• On average in the EU-27, 36 % of board members were women in 2010, whereas in 2007 they represented only 22 %, an increase which is influenced to a certain extent by changes in the computing methods for the EU average.

Differences in boys' and girls' way of learning / behavior – Classroom Practices

According to the literature (UNESCO Guidelines for Mainstreaming Gender in Literacy Materials, PREMA project, TWIST project, PRAGES project, Equity Initiatives for Science and Mathematics), the learning behavior of girls and boys differs. While the variance might be partly due to biological factors, current research focuses on behavior aspects in teaching / learning. The genders are likely to process information and behave in a classroom in different ways.

Boys take a more abstract and holistic approach, are more receptive to symbols and formulas and because competition seems to be a good motivator for them to learn, they are often more competitive in their behavior. Girls, on the other hand, tend to process information more sequentially and systematically; they are more linguistic, have a greater eye for detail and find tangible and concrete examples more appealing.

It is important to note that these differences are generalized for all boys and girls, based on research results. There will always be exceptions. Every child is different. Variations in the way children learn are found not only between the genders, but also within them. However, when teachers are aware of the general differences between boys and girls and know how to respond to them, the education of the whole class could be significantly more effective. We therefore need to acknowledge and encourage both ways of learning. Not only by differentiating the way we teach boys or girls, but by integrating both ways of learning into our teaching methods. In addition, teachers should be aware of their own ways of learning. Just like their students, male and female teachers may have a more "boy-like" or "girl-like" way of learning – which could make their teaching methods more suitable for either boys or girls. It is important to understand that a teacher's way of learning and a teacher's preferred teaching methods may not suit all students.

IV.1 Classroom Practices

A short outline of issues to be attended in Student/Teacher interaction is presented here below:

- Give equal attention to girls and boys. Call on girls as often as you do boys - ask boys and girls questions which are equally demanding.
- Have high expectations of both male and female students. Do not encourage learned helplessness by over-nurturing the girls.
- Encourage girls to be active learners by using manipulative and providing hands-on learning experiences.
- Use gender-free language in classroom discourse. Eliminate sexism in your use of language.
- Use quality, precise feedback to girls' as well as boys' answers - not just a nod or a "good."
- Make eye contact with all students and call them by name.
- Understand that girls generally begin processing information on the brain's left, or language, side. So, girls deconstruct science concepts verbally. Looking at something on a board or screen is not enough. They need to unpack the problem using language. They need to "talk it through".
- Provide adequate wait time, perhaps 3 or 5 seconds, before calling on a student to answer the question. Females often wait until they have formulated an answer before they raise their hands; boys often raise their hands immediately and then formulate an answer.
- Have girls read instructions aloud. When girls eventually perform science experiments, even when the project is relatively easy, this will help them break down the steps involved. It also helps with deconstructing more elaborate math problems down the road.
- Never tell girls the answer. The point of science is not so much to get the answer but to figure out how to get it. The more you do for your students the more you short circuit their self-esteem. If they are stuck on something, keep asking questions.
- Do not interrupt girls or let other students do so.
- Refrain from recruiting students to perform classroom "chores" based on traditional gender roles. Do not ask only boys to assist in carrying boxes and girls to clean the bookshelves.

As for the Lesson Planning/Classroom Management the following issues should be considered:

- Emphasize that we live in a scientific world. Girls can be increasingly resistant to the idea of "science" as a standalone subject until they reach middle school. When the same scientific principles are presented to them as "social studies", they become invariably receptive and energetic students.
- Raise the "fun-factor" in science lessons by e.g. including games, by offering a variety of teaching methods and by relating the subject matter to students' interests. For example, interactive teaching methods have proved efficiency in preventing gender gap in science teaching.
- Avoid gender -based stereotypes in the educational activities, experiments, teaching materials and teaching programmes. Give equal attention to girls and boys – giving boys and girls tasks which are equally demanding.
- Balance cooperative and competitive activities. Most girls learn more readily in cooperative situations.
- Establish rules for participation and rotate jobs within each group.
- Give girls an equal amount of assistance and feedback. Boys usually receive more help and praise that builds self-esteem.
- Stress safety precautions instead of dangers for certain activities such as laboratory experiments.
- Avoid the digital gender gap by encouraging equity in ICT use. Insist that girls as well as boys learn to set up and use all electronic equipment.
- Address inappropriate behavior with a fair and respectful attitude, regardless of gender, race, ethnicity, or socioeconomic class of students.
- Use computer and lab partners. Again, most girls work better in cooperative groups or teams.
- Provide female role models. Girls need to see females in certain professions or career choices in order to visualize themselves in the same or similar roles; whereas boys need only to hear about certain roles to imagine themselves taking place in those same roles.
- Provide learning experiences for girls to develop spatial visualization skills.
- Create an attractive classroom environment. Girls learn better in an aesthetically pleasing environment.

IV. 2 Gender Equality in the context of NTSE

The project is aware of the European priorities and tendencies concerning the science education in girls. That is why it defines as its objectives to apply gender equity sensitive approaches and pedagogies toward teaching/learning about nanotechnologies. NTSE Team has paid strict attention to balance the number of participants while designing the national and international events. These are the figures based on the numbers of female and male participants of NTSE Project test implementation period, poster competition and science camp. The data for the test implementation period is not shown on a table due to the fact that the implementations still continue. However, special attention is paid to keep number of male and female participants in balance.

COUNTRY	GENDER		TOTAL
	FEMALE	MALE	
BULGARIA	6	13	19
GREECE	14	13	27
ITALY	28	16	44
ROMANIA	20	8	28
TURKEY	31	48	79

Table 1: The number of participants for the poster competition based on gender

COUNTRY	GENDER		TOTAL
	FEMALE	MALE	
BULGARIA	4	3	7
GREECE	2	2	4
ITALY	2	4	6
ROMANIA	6	0	6
TURKEY	5	8	13

Table 2: The number of participants for the science camp based on gender

V. Conclusions

The Nano Project Virtual Laboratory represents an important step in understanding basic nano concepts, being dedicated basically to pupils, students and in-service teachers, but also with a great exploitation potential by university students, prospective teachers, education stakeholders, researchers and academic staff. The main idea of building such a virtual resource is based on the principle to make the content as simple for use and exploitation as possible, understandable and attractive, but also to involve and include inquiry-based methods for the proposed application that encourage learners to think about nano processes and phenomena, and to find solutions and exchange information through several channels (as blog or videoconference).

The implementation process of the Nano Project Virtual Laboratory has illustrated a great potential at all the educational levels, in this way, the project partnership is being encouraged to pay real attention to the exploitation process in promoting the Virtual Laboratory and its resources to various educational, professional and school / academic networks of which the partners are members.

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NTSE-Nanotech Science Education project is a KA3 Transversal Multilateral Project aiming to raise the awareness of ICT supported learning, through Nano technology in Science Education, at all levels of education and training. NTSE creates a new direction in teaching science by means of ICT and by making science education more attractive and applicable to students (aged: 13-18), teachers and prospective science teachers of all backgrounds. Virtual Lab is designed to improve the scientific judgment of students via an inquiry-based learning concept exploring the role of creativity and innovation in education and training against the backdrop of dramatic change in how, where and what learners learn.

Project outcomes:

➡ Nano-Science Camp training, with hands-on experiments and demonstrations

➡ Nano-Technology poster addressing the students between the age 13 to 18.

➡ INT-NTSE International Nano-Tech Science Education Congress.

➡ Nano-Tech Guidelines with the brief information on Virtual Lab and Nano-Tech Annual with facts, statistics and graphics about the project.

➡ The workshop & webinar providing basic information on how to effectively use the virtual lab in the classroom.

www.ntse-nanotech.eu/webinar.

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