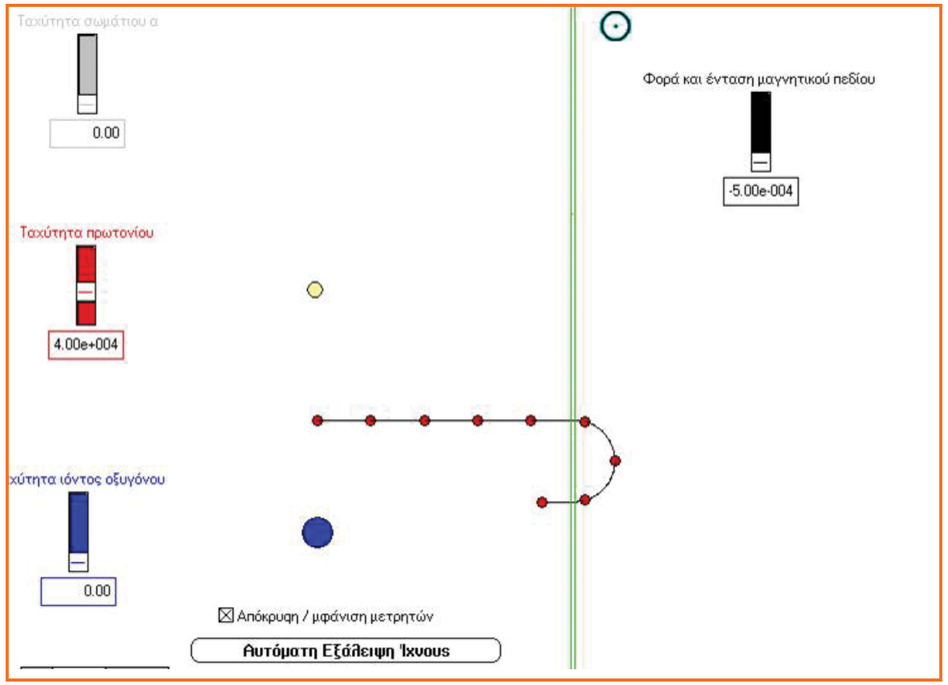
Activities implementing IBSE-ICT-PCK, using Interactive Physics,Modellus, MultiLog, IrYdium Chemistry Lab, Autograph, Mathematica



Summary:

Different scenario based on the integration of ICT with IBSE are included in order to advance students' understating of scientific concepts and use ICT as Cognitive Tools for meaningful learning. Most of the scenario are strongly connected to real life situations.

The Scenario will be implemented by teachers in their class aiming to investigate the impact of the integration of IBSE-ICT to students' learning performance and to affective-psychological issues towards Science Education.

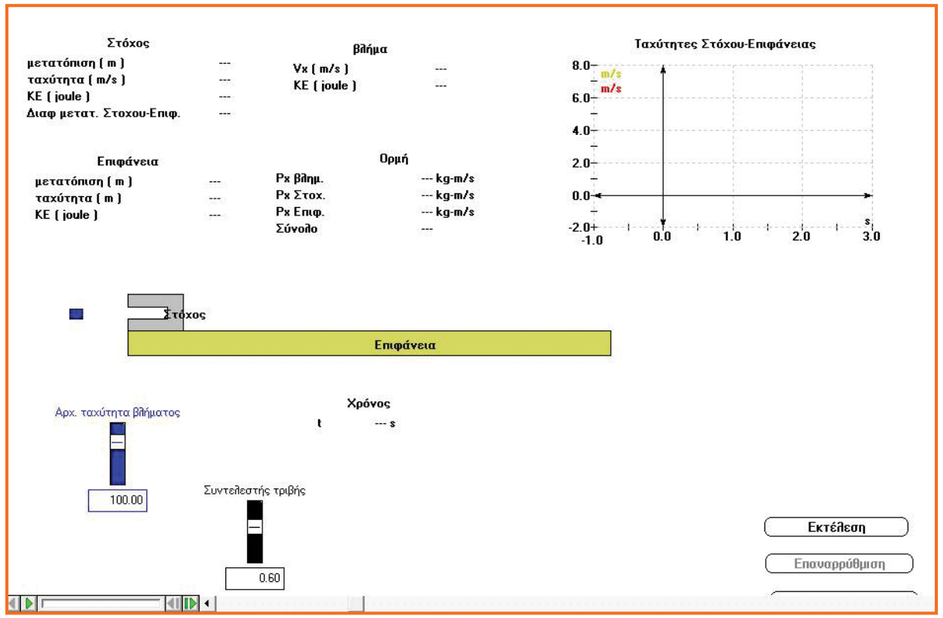
Aims:

To demonstrate ICT based scenario that provide the opportunity for students a) to explore and investigate the validity and limitations of certain physical laws and properties using Inquiry Based Instructional Methods and ICT based learning environments, i.e. the use ICT tools as cognitive tools and b) to conduct inquiries that enable them to engage actively with questions and problems associated with their subject or discipline, to explore scientific principles, to analyze data, to make hypotheses , to predict situations, to communicate the results of their involvement through the manipulation of the entities of the applications.

Main activities:

Teachers responsible for the implementation of the activities will apply the scenario at their classes. Teachers have the experience to develop scenario based on the IBSE-ICT as they attended a training course for the exploitation of the use of ICT as Cognitive Tools for the Didactics of Science. Scenario are already develop and refer to the categories: "what scientists do", since students will investigate the scientific phenomena by using scientific methods in order to explain aspects of the physical world; "how students learn", by pursuing scientific questions and engaging in scientific experiments by emulating the practices and processes used by scientists ; and, a pedagogy, or teaching strategy, adopted by science teachers (designing and facilitating learning activities that allow students to observe, experiment and review what is known in light of evidence) (Pathway Reports 2.1,2.2 and Minner et al 2010).

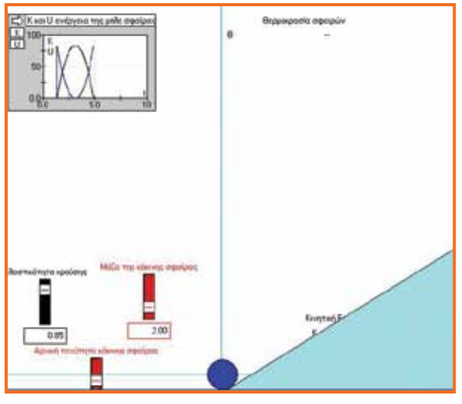
The procedure is the following: teacher trainees have been trained for the development of Inquiry Based scenario integrating PCK with ICT and they will undertake the task to apply different scenario based in Inquiry Based Learning integrated with the essential features of IBSE as they are described by the Deliverables of Pathway.



Activities implementing IBSE-ICT-PCK, using Interactive Physics,Modellus, MultiLog, IrYdium Chemistry Lab, Autograph, Mathematica

Narrative:

Best practices are in the form of scenario developed and implemented by experienced teacher trainees. Scenario integrates ICT, IBSE and PCK while ICT is considered as a cognitive tool aiming to meaningful learning. Scenario are written in Greek and they have been developed in the form of a learning cycle implemented at schools and at specific teachers' training centers. Teachers involved were trained for 360 hours for the exploitation of ICT in Didactics, and will be the actors/agents/multipliers who will apply their scenario to their class . These scenario are already evaluated during teachers' training course and will form best practices for understanding Subject Matter (e.g., conservation of momentum ,angular momentum and energy, the oscillation and the electric circuit RLC, Computational Chemistry, Biology). Students will engage in a series of guided/coupled inquiry and open inquiry (e.g for the development of Model using the Autograph), the development of Basic Competencies Necessary to Do Scientific Inquiry (e.g., students make hypotheses, formulate and revise scientific explanations and models using logic and evidence). Through the applications students will be involved in gathering and analysis of data using simple representations (like the one provided inherently in Interactive Physics, Modellus and Multilog, IrYdium). All the scenario will provide the opportunity for students to solicit multiple approaches to solve specific scientific problems. All the scenario contain the main features of Inquiry.



Scenario1. Conservation of Energy using Interactive Physics Grade 10&12
Main scientifically-oriented question/ problem: Conservation through the collision of particles

Scenario 2. The study of the Lorenz Force using the Interactive Physics-Grade 11
Main scientifically-oriented question/ problem: Motion under the Lorenz Force

Scenario 3. Study of the Collisions with Friction using Interactive Physics-Grade 12
Main scientifically-oriented question/ problem: Motion after the collision and use frame of reference

Scenario 4. Conservation of Angular Momentum-Interactive Physics-Grade 12
Main scientifically-oriented question/ problem: Study of the conservation of angular momentum during the collision of a body with a solid bar

Scenario 5. Study of Oscillation using Mathematica
Main scientifically-oriented question/ problem: develop a mathematical model in Mathematica

Scenario 6. Study of Oscillation-RLC Circuit using MultiLog and Modellus
Main scientifically-oriented question/ problem: Investigate the properties of oscillation and circuits

Scenario 7. A modeling for "Crows use their to break nuts" Mathematics and Autograph to – develop a model to better fit the data. Main scientifically-oriented question/ problem: find a model to fit the data gathered from authentic experiment

Scenario 8.Electromagnetic Induction using Multi Log-Grade 11

Scenario 9. Computational Chemistry-Study of solutions of acids, bases and salts using IrYdikum.

Scenario 10. Oscillations using Modellus and MultiLog

Scenario 11.Three multimedia applications for the determination of the %v/v beverages' concentration - Alcohols using the software LCDS, IRYDIUM, The Marvelous Chemical World.

Activity 12. Biology activities using software and will be uploaded to www.spsycharis.gr.

End user:
The end user is the one who learns with the material. Children grade X/ age X, GRADE 10, 11,12 Students for the Discipline of Natural Sciences
Involved actors: Teachers
Location: Schools/ teachers training centers
Languages available: Greek
Where to find the application or case: www.spsycharis.gr at the part dedicated to Pathway
Duration: Open ended
Evaluation parameters:
Questionnaires were distributed to the teachers who took part at the training center and results were described in a conference(Psycharis,S.& Botsari,E. (2011). The impact of the Computational Experiment to Inquiry Based Science Education and Pedagogical Content Knowledge. GUIDE INTERNATIONAL CONFERENCE 2011. "E-learning innovative models for the integration of education, technology and research" . Università degli Studi "Guglielmo Marconi" .Rome, 18 – 19 November 2011) . Teachers will implement the scenario at their classes and also –operating as trainers- to other teachers at specific training centers. Questionnaires included questions about the effectiveness in learning and on affective issues and motives for science education. Collection of data will be use for the analysis of the results concerning the effectiveness of the scenario for the learning performance as well as the impact of the combined ICT-IBSE approach to students' attitudes and motives for Science Education and Inquiry.
Connection with the curriculum: All the activities cover the current curriculum for Grade 10,11,12 students. Slight modifications could apply to the applications to be appropriate for Grade 9 students.

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	
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:

ICT based scenario will enhance the processes of observing, questioning, investigating and reasoning about evidence through which knowledge and theories are developed and changed. Students will have the opportunity to change the methods and attributes of the entities used in the software and study the interactions of the entities under these changes and increasing their interest in Science.

2. Building up informed citizens: Students understanding the nature of Science & Science in society:

Specific scenario are well fitted to authentic tasks(like the one based on Authograph, and he scenario for the beverages). The scenario developed in Computational Chemistry is related to the connection between Science and Society and deals with through the creation of chemical products used in everyday life.

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**

During the running of the simulations, students are expected to develop skills of framing questions and finding ways of gathering data by observation and measurement to answer them, analysing and interpreting data, and engaging in discussion about findings and the process of arriving at them. For example using the MultiLog software, students collect data and plot them, examine the validity of the well known law(described in the textbook) and interpret data.

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

All the activities involve modelling, simulation, mathematics. For example in all applications based using the Modellus, students have to write down the mathematical relations in the form of first order differential equations. Scenario combine the cognitive analysis of conceptual change processes in students with the examination of instructional dialogue integrating socio-cognitive methods.

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

Scenario are close to authentic situations. For example, using the MultiLog software students are engaged with different types of sensors to connect the activities with real life authentic problems. The scenario implemented in Autograph is purely related to real life situations. The scenario concerning the measurement of the %v/v beverages' concentration is a situation confronted in everday life.

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

Students' explanations will grow steadily during the instructional strategies as well as students' conceptual changes resulting to a sequence of intermediate models that become progressively more scientifically based. This suggests a model evolution where students are able to build on knowledge that they had developed in earlier stages.

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

All the modeling based applications are scientifically concise and compact while the activities involve a kind of Constructive modelling ,i.e. a process of abstracting and integrating elements from successive models related to the target problem.

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

All the scenario promote an inquiry-based and problem solving learning approach. ICT is included as a cognitive tool and can serve as a fullilement of certain inquiry features in the didactic scenario. For example by analyzing the data produced by the real time simulation students will be able to redefine their explanations, to determine how ideas are related to one another, and the limitations of the theory.

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

An initial assessment will be implemented in order to measure the effectiveness of the proposed Scenario, not only for the learning performance but also for the relation of ICT-IBSE with the learning styles and the motive for doing Science. Specific-well established- questionnaires will be used.

10. Cooperation among teachers and with experts:

During the training period, teachers triggered a discussion about the integration of ICT with IBSE and how the esential features of IBSE will be integrated with ICT tools, what kinds of ICT we are really need and how we can transformt he simulation and modelling in order to include IBSE. They also discussed issues like scafffoded based software.