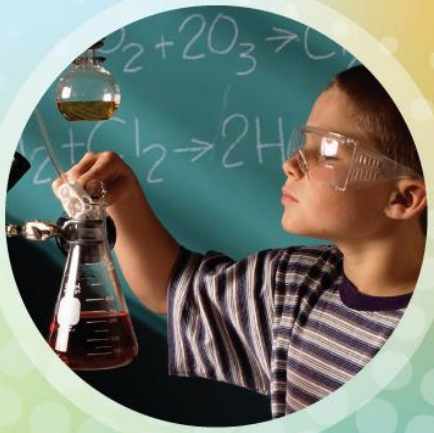
NDSTE2014

1st International Conference on New Developments in Science and Technology Education



BOOK OF ABSTRACTS

May 29 - 31 2014

HOTEL CORFU HOLIDAY PALACE
Corfu Island, Greece

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NDSTE 2014

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Welcome

Dear Colleagues,

We are proud and honored to announce the First International Conference on "***New Developments in Science and Technology Education***" that will be held in Corfu Island, Greece, from Thursday, May 29th, to Saturday, May 31st, 2014.

Science and technology education research not only concentrates on the teaching of science concepts and addressing misconceptions that learners may hold, but also as they co-evolve they examine and integrate into their epistemologies innovative approaches such as Inquiry-Based Science Learning that situates learning in authentic science practices. New developments in science and technology education rely on a wide variety of methods, borrowed from many other sciences such as computer science, cognitive science, sociology and neurosciences.

A lot of studies indicate that students who use new technologies, enlightened by new developments in science education, not only get better grades on exams, but also demonstrate better understanding. Constructing and using scientific conceptual models are also necessary in order to reach high levels of scientific literacy. Therefore, it is important for science courses to be designed in ways that support and help students understand the pivotal role of models in scientific episteme and of modeling in scientific inquiry.

The conference will be structured around (but not limited to) five main thematic axes such as:

- Modern Pedagogies and New Technologies in Science and Technology Education
- Interest, Attitude and Motivation in Science and Technology Education
- Neuroscience and Science Education
- Assessment in Science and Technology Education
- Teaching and Learning in Specific Disciplines

The conference has two objectives. The first objective is the sharing of new practices within the area of research in science and technology education. The second objective is to provide international researchers a significant and friendly opportunity to network and collaborate so as to improve ideas and processes.

The organizers,
Professor Martin Riopel
Assistant Professor Zacharoula Smyrnaiou

Keynote Lectures

K.L. Thursday 29 May 17:00-18:00

Five Powerful Ideas about Technology and Education

By Prof. Andrea A. DiSessa, Graduate School of Education, University of California, Berkeley

I will present "five powerful ideas" concerning the very best ways to enhance education via computers and technology generally. These ideas have stood the test of time in that they have guided decades of my own work, and they have been reinforced and adjusted as we have had experience with them. Some of them even originated in surprising experiences that we had teaching with technology.

I believe these powerful ideas are subtle, deep, and unfamiliar to many. A "once in several centuries innovation," information technology impinges on profound epistemological and cultural issues. None of them are "easy to implement," and there are also cultural dissonances with popular ways of understanding how to use technology in education. My talk will motivate and introduce the ideas, will seek to bring them to life in examples, and will include commentary on avenues of progress and also on blocks and limitations to quicker progress.

K.L. Thursday 29 May 18:00-19:00

Questionning simulations to question intuitions

By Prof. Chronis Kynigos, Faculty of Philosophy, Education and Psychology, EDUCATIONAL TECHNOLOGY LAB, National and Kapodistrian University of Athens, Greece

Constructionism as an educational design paradigm or a theory about a particular kind of learning has never really been at the centre of science education. Phenomenology, inquiry learning and challenge based paradigms have been more pertinent and designs for digital media for science education have been perceived mainly in this frame. A classical and longitudinal research to understand the nature of experience based intuitions about the physical world, how these may lead to deeply ingrained misconceptions and how an important part of science education is to challenge these to bring about conceptual change around phenomena has been a central theme. Digital media provide simulations built so that they represent physical phenomena as accurately as possible so that students can, through experimentation, challenge their intuitions. This paper addresses the question of whether and how the constructionist paradigm can contribute to the generation of understandings either through challenging intuitions or building new ones. I will discuss digital media intentionally built so as to embody faulty simulations of phenomena so that students are placed in the role of

questioning the simulations themselves. Recent designs allow for digital media to invite access to the very rules with which even technically complex faulty simulations were built and thus allow students to question and change the simulations deriving meanings through collective de-bugging and argumentation on the degree to which a simulation represents a phenomenon. A small number of such simulations will be discussed in detail with respect to their design and the alternatives they may bring to science education.

K.L. Friday 30 May 11:00-12:00

Science & Technology Education and Mathematics: the Literacies' perspective

By Dr. NIkitas Kastis, President of the Management Board at Hellenic Association for Education (HAEd), President of MENON

Evidently Science & Technology together with Mathematics have long been perceived – and managed - as the most demanding areas of learning and further to the Language and the Social Sciences related subjects, in K-12 Education, rather "expensive" to be afforded, while mainly targeted at the elites of the school population.

In parallel, there is the widely shared perception that societies and economies should prioritise at the highest level the learning achievements of their off-springs in STEM, as the guarantee for a future with sustainable economic growth – in other words STEM achievements in the PISA are often included in various benchmarking frameworks to measure competitiveness of economies and societies.

And at the same time, a significant part of curriculum-related and pedagogical innovations being introduced, often with an ICT-driven agenda, in Pre-school and K-12 Education, in both the European and other regions' school systems, have to do with STEM and the validation of state-of-the-art learning context, with inquiry and project-based, collaborative learning pilots. Interestingly, the latest SITES Study has shown that, contrary perhaps to what has been expected, ICT-facilitated pedagogies are scarcely deployed in the teaching and learning of Maths, while the majority of the successfully validated of ICT-enhanced learning innovations have to do with language learning and science education.

This is what hard evidence says, with the afore-mentioned aspects corresponding to two of the critical dimensions of the educational policies of our time. First of all, how and to which extent the effectiveness of science and maths learning, as they both correspond to two of the so-called key competences to be considered as the emerging literacies, has an impact on the competitiveness of a developed economy in the 21st century. And then, how the emerging science and maths learning paradigm shift, we are experiencing in a significant number of advanced school education systems across the board can become a sustainable pedagogical innovation towards an upgraded competence oriented learning experiences for structured learning settings.

These aspects will be fostered and reflected upon during the presentation, while participants will be invited to contribute with their knowledge and understanding to a foresight exercise.

K.L. Friday 30 May 12:00-13:00

The interplay of domain-specific and domain general processes, skills and abilities in the development of science knowledge

By Prof. Stella Vosniadou, Department of Philosophy and History of Science (M.I.Th.E) National and Kapodistrian University of Athens, Greece

I will argue that children construct a naive physics which is based on observation in the context of lay culture and which forms a relatively coherent conceptual system – i.e. a framework theory – that can be used as a basis for explanation and prediction of everyday phenomena. Learning science requires fundamental ontological, epistemological, and representational changes in naive physics, which depend in important ways on certain domain general processes, skills, or abilities, such as executive functions, spatial reasoning, and representational ability. These conceptual changes take a long time to be achieved, giving rise to fragmentation and synthetic conceptions in the process. I will also argue that both fragmented and synthetic conceptions can be explained to result from learners' attempts assimilate scientific information into their existing but incompatible naive physics. Finally I will also argue that naïve physics does not go away but continues to exist and to inhibit access to scientific concepts even after many years of science instruction.

K.L. Friday 30 May 19:30 - 20:30

Cultivating student's interest in science and technology: what do we know and what should we do next?

By Prof. Patrice Potvin, Département de didactique, Université du Québec à Montréal (UQÀM), Canada

Governments, schools, parents and businesses everywhere have recognized the importance of students' interest toward science and technology, hoping for human, economic, personal, collective or strategic benefits. However, the available knowledge we have about the state of interest, its evolution and the factors that affect it does not always go far beyond common sense. Based on a rather extensive review of research articles in the field and on the results of a survey conducted among nearly 2000 grade 5-12 students, we will present five main (and perhaps a little uncommon) conclusions that have been drawn by the CRIJEST (Research Chair on student's interest in S&T) during its first years of existence. Based on these conclusions, recommendations for improving interventions and for further research will be presented.

K.L. Saturday 31 May 10:30 - 11:30

Intuitive interference: Insights from behavioural, brain imaging and intervention studies

By Prof. Ruth Stavy& Dr. Reuven Babai, Department of Science Education, The Constantiner School of Education, Sagol School of Neuroscience, Tel Aviv University, Israel

It is well known that students encounter difficulties in solving a wide range of problems in science education. Several explanations to students' difficulties were given in the last decades by researchers in science education. Our research indicates that some of these difficulties may stem from intuitive interference of a salient (automatically/intuitively processed) irrelevant variable with formal/logical reasoning about the relevant variable. This interference is reflected in students' erroneous responses to numerous tasks in science education.

Our research goal is to deepen our understanding of the nature of this interference and to unveil the reasoning processes associated with overcoming it. For this purpose we explored this interference using several tasks and conditions, employing cognitive psychology methods (e.g., reaction time) and neuroscience techniques (e.g., functional Magnetic Resonance Imaging - fMRI).

In the lecture we will describe and discuss these recent studies and show how they led us to develop successful educational interventions.

K.L. Saturday 31 May 11:30 - 12:30

The Beauty of Equations: Learning Science with Computers Without Being Afraid of Mathematics

By Prof. Vitor Duarte Teodoro, Faculty of Science and Technology, Universidade Nova de Lisboa, Portugal.

Thirty years after the beginning of the use of computers in science education, Power Point presentations are probably the only type of computer use in most classrooms. Measurement and data-logging, spreadsheets and modelling, are used only by a minority of teachers and it is common to find teachers using regularly computers in classrooms that have never experienced other tools besides Power Point.

Scientists of all fields routinely use measurement and modelling with computers, at least since the late 1980s. The fact that this doesn't happen in most classrooms tell us that students don't have contact with how science is really done today. Many European and national projects have aimed to change this situation but it seems that they have not been successful enough. Some years ago, Jon Ogborn, a leading science educator and pioneer in the use of computers in science education, wrote: "The more general question now is whether computational modelling can radically simplify and illuminate the reasoning needed in mechanics and other problems. It seems clear to me that it can. I have no insight at all into why this didactic invention has proved so difficult for most teachers to accept." Ogborn doesn't have any insight on why it is difficult to teach

science using computer modelling but I can suggest at least one reason: science is mainly taught as a "product", a collection of facts and rules. The processes of science are most of the times absent from classrooms. This is certainly the reason why the Rocard Report still insists on "inquiry-based science education", sixty years after the promises of the new approaches promoted in the science curriculum changes of the 1960s.

How can the research community in science education make a relevant contribution to change this state of affairs? In this talk I will make a few proposals and give examples, starting from the principle that curriculum development and professional development of teachers in science and mathematics should be a joint effort, with a strong emphasis in embedding powerful computational tools on the day-to-day management of classrooms.

K.L. Saturday 31 May 19:00 - 20:00

Constructing yourself in school science

By Professor Kathrin Otrel-Cass, Department of Learning and Philosophy, Aalborg University, Denmark

It has been repeatedly argued that young people need to acquire science knowledge, skills and competencies, so that future economies can maintain social welfare, economic growth and international competitiveness. However, the attainment of understanding in science is not the only importance of school science. Classrooms together with the new technological tools that are being used are places that fabricate and (re)align how young people see themselves in science and form their subjectivity in relation to society's core values and rationalities and are embodied in primary science education practices. This article is concerned with subjectivity, meaning the sense and experience of self that children construct while being part of school science and the role that digital technology plays. Research conducted in New Zealand and Denmark illustrates examples of different educational cultures found in science classrooms. The findings suggest that digital tools used in classrooms expand not only the means of teaching and learning science but represent spaces for the emergence, negotiation and struggle of different forms of subjectivities.

Modern Pedagogies in Science and Technology Education Sessions

Friday 30 May 14:00-15:40

Mathematical meaning- making through creative designs

By Chronis Kynigos, Foteini Moustaki

In the past few years, "creativity" has been considered a central lifelong competency for all, an important add-on to the e-skills that a student shall need in the new era of economic and social challenges. However, designing ICT tools and pedagogies that would allow students to creatively address mathematical problems is not a new field of interest for the researchers. Exploratory environments combining visual representations, dynamic manipulation and the use of mathematical formalism in the form of programming and have been used by students as expressive media, allowing them to approach and experiment in novel ways with mathematical ideas. This paper describes creative designs that educators have deployed in their attempt to generate situations that would foster mathematical creativity for their students.

Reflexive Return and Quality of the Language using Information and Communication Technologies

By Michel Pronovost, Katerine Deslauriers

The quality of French language is a priority for all colleges of Quebec. It was highly studied, but this is the first time that science and non-science students are compared regarding to their quality of language. Our study measured the effects of revision (auto correction and rewriting) of texts written by science students and non-science students on the perception of their capacity to improve at the level of the language by using information and communication technologies. During the session, students had to write three texts (the first one by hand and the others with computer). Teachers corrected the writings by indicating the mistakes. Students then had to rework their texts using different tools including technological tools and hand them back to their teachers who recorrected them. The sample (n=148) was mainly composed of girls (64.9 %). It was composed of students registered in a pre-university program (46.9% in science) that mainly speak French at home (73 %). The majority of the students have access to a software of correction of the language at the home (56.8 %). Science students consider them less competent to use Antidote that those who are not in sciences (t=5,594, p =, 000). They thus use it less for the revision of their school works (t=4.643, p =.000). Science students consider more useful the comments of their professors than the other students (t=2.02, p=.044). They understand them better (t=2.15, p=.032) and feel more capable of satisfying the requirements of their professors (t=2.25, p=.025). Science students make more spelling mistakes (t=3.10, p=.002), grammar (t=3.30, p=.001), punctuation (t=2.92, p=.004), syntax (t=7.20, p=.000), grammar of the text (t=4.13, p=.000), vocabulary (t=1.86, p=.064) and specific vocabulary mistakes (t=5.90, p=.000)

than those who are not in science. Students in science, although they had better marks in high school (t=5.38, p=.000) and better R score in college, had no significant difference in French marks at high school than the others. At home, students use more the virtual tools than the paper ones even though they have access to them. At the end of the session, the reflexive return on their works and the fact of having been able to work again their texts brought them a global vision on the quality of their written French. Reflexive return allowed the students to identify the strengths and the gaps that are specific errors in French, general quality of the contents of the text, precision and depth of their ideas. We can conclude that, when we give them the time and the opportunity to review their texts, they get satisfaction from it and some pleasure.

Community of practice and its applied results in the teaching of science-technology of the Secondary sector (high school)

By Diane Gauthier Ph. D., Ugo Collard-Fortin M.A.

The various school reforms worldwide Westerner gave rise to the addition of the technology in the courses of science. Besides, this addition has created a movement of tautness within the teaching staff. The initial schooling of the teachers did not lead them to develop practical applications of the scientific and technological concepts which they have to teach. Furthermore, the sessions of laboratory prepared within the framework of their courses represent concrete applications of the theory. Studies led on the technological knowledge state of essential presence of normative components connected with this education in schools. Certain educational practices associated with the expression of the critical thought on the function and the technological functioning of artefacts would be favorable to their appropriation. In this circumstance, it becomes a priority that the pupil is made sensitive in the respect with which engineers and technicians have to grant to the characteristic standards to the conception of technological objects and to the consequences which they may have on the ecosystem (natural environment). The school milieu via the education of the science-technology has to allow the pupil to develop analytical tools which he can possibly reuse in situations in which he will be challenged as a citizen. In order to adapt the teachers' practices to the contents of the various programs of science-technology of the secondary sector (high school), an in-service training was setting up in the region of Saguenay-Lac-St-Jean (QC, CAN). This development realized in a context of support in community of practice permitted to the teachers to elaborate activities linked with the technological knowledge and to verify them in class with their pupils. According to the results observed and analysed, this configuration of pedagogical development have potentially modified their perceptions of the technology education and improved their professional practice.

Screening Dyscalculia and Algorithmic Thinking Difficulties

By Plerou Antonia, Vlamos Panagiotis, Kourouthanasis Panagiotis

Rapid changes in information and educational technologies motivate an evaluation of new prospective in diagnostic evaluation of learning disabilities in mathematics and algorithmic thinking difficulties. People are in general exposed to numeric computation during their mathematical education but they are not always proficient enough while thinking algorithmically. This means that they have troubles developing, applying and

evaluating a formal step-wise algorithm for solving a given problem. It is worth mentioning that research referring to algorithmic thinking difficulties and the way they could be identified is bounded. In this paper a new diagnostic screening tool is proposed concerning difficulties in mathematics known as dyscalculia and algorithmic thinking difficulties. Screener specifications are also presented and new information and interaction technology is also proposed in order to support users in risk in dyscalculia and algorithmic thinking difficulties

Teaching of the Renewable Energy Sources to Secondary School Students With Science Activities Based on Socio-Scientific Argumentation

By Gülsüm Yasemin ŞAHİNTÜRK, Mehtap YURDATAPAN

Energy and power became an essential part of social life in this century. With the advancing technology and growing demand, both the source of energy and whether the decisions on the existent energy sources are scientific and feasible have become a critical issue of today. In terms of science education, renewable energy sources as a socio-scientific subject can be used by the educators during the teaching of the decision making and implementation stages on the energy policies. Since the scientific argumentation is a new method on the science teaching, the recognition of its importance by the researchers is increasing over time, leading to a rise in the number of related research.

The aim of this study is the examination the effect of the science activities based on socio-scientific argumentation on the development of the renewable energy content knowledge of 8th grade students, and the students' opinions on the scientific argumentation. For this purpose, activities were conducted with 80 eighth-grade students in an experiment and control group. The study has taken 16 course hours. During the process, while the science activities based on socio-scientific argumentations were applied on the experiment group, lectures were given via activities prepared with the constructivist education system stipulated by the curriculum. One of the two surveys used in the study, which was prepared by the researchers, consists of 10 open-ended questions. With this survey it is aimed to determinate development in the students' renewable energy knowledge level. In the survey the answers given by the students were coded. The answers will be classified and analyzed via these codifications and the pretest and posttest knowledge levels will be compared. The other survey called "Scientific Argumentation Opinion Survey" is a Likert-type one consisting of 20 questions prepared by the researchers. It is used for the determination of the opinions of each student involved in the experiment group about the methodology. The analysis of the data derived from the surveys is still in progress.

We believe that this study can make a significant contribution to other research on the fields of renewable energy teaching and scientific argumentation.

Concept mapping as cognitive tool in science education: An analysis of students' learning using SOLO taxonomy

By Vasiliki Bakouli, Athanassios Jimoyiannis

The current theoretical models in education are driven by constructivist theories of learning and they are focused on creating new learning environments offering enhanced opportunities to the students for active involvement, planning and managing their own learning. In this participative learning context, Information and Communication Technologies (ICT) are perceived as the means to develop enhanced learning environments that would lead to new educational practices facilitating both, constructivist learning and students' critical and higher order thinking. Concept Mapping (CM) software is a popular tool among educators, suitable to support different type of learning activities, and to achieve learning outcomes in different subjects and educational levels. Within the context of constructivist learning, concept mapping is viewed as a cognitive tool, aiming to support students' active learning, analytical and critical thinking, creativity, conceptual change and knowledge construction.

Research data already published offer significant knowledge regarding students' difficulties and their alternative representations about science concepts. However, there are still a lot of open issues regarding science education and, particularly, the appropriate educational practices in primary school. In addition, science education is considered as an ideal subject to design and investigate CM-based learning activities aiming to help students to overcome their misconceptions and to reform/rebuild their mental models about concepts, processes and systems of the natural world. However, primary education students' learning and cognitive development, when they use CM, have not been extensively studied.

This study was designed with the objective a) to investigate how concept mapping can contribute to knowledge construction in primary science education, and b) to study individual students' cognitive development during a learning intervention with CM. An instructional sequence of constructivist learning activities, based on concept mapping, was designed and implemented in a K-6 experiment class including 14 students. The sequence was evolved in a total of 14 lesson hours over a 5 week period. The participants were asked to use CM for organizing their personal knowledge, representing and expressing what they have learned, during the learning sequence, in the topics of human respiratory and circulatory systems. They were engaged in specific learning activities and they created a series of artefacts (concept maps) using both methods, "paper-and-pencil" and the "Inspiration" software.

Qualitative research data were collected during the learning sequence workflow in the classroom: a) students' CM artefacts, and b) researchers' observation notes. Students' concept maps were analysed and classified according to the different levels of the Structure of the Observed Learning Outcomes (SOLO) taxonomy. The results of the study revealed students' individual development along the learning sequence. Students in the experiment group tended to manifest higher order learning outcomes; they showed more responses in multistructural and relational levels, compared to their fellows in the control group. The paper concludes that concept mapping is an effective learning strategy that could be easily integrated into the science classroom. Finally, suggestions will be drawn for learning design and practice to enhance students' active and constructive learning using CM software.

Constructing the science of celestial bodies for preschool-aged children: A teaching proposal

By Michail Kalogiannakis, Konstantinos Chazipapas

Shape and size of Earth and planets, as well as several issues by the macrocosm employ human over time. Generally speaking, constructing the science on celestial bodies, from preschool age, is one particular challenging educational process. The social aspect of learning through field interactions like museums, parks and other informal learning centers, is the heart of learning experience for preschoolers. The fact that children can play and have fun in such environments is seen as a significant asset for the entire educational process.

In the framework of this study we present a two days teaching intervention on discovering the science behind celestial bodies. We created a detailed teaching intervention, with various activities aimed at children of preschool age. Our principal objective is the pursuit of basic concepts about Earth, gravity and planetary motion, by preschool's children using ICT.

The intervention starts with drawings and constructions made of paper or clay. It is asked on children, to construct Earth and people on it, using any material suits them. As an initial basic source of "inspiration" inside the classroom, it is suggested an existence of globes, maps and computers that will present relevant slide show or Google Earth. After we collect all children's constructions, it is important to discuss what their creations represent. The development of relevant arguments between children is desirable, while teacher operates primarily as a facilitator. Then teams gather spherical objects of various sizes from ping-pong balls, to fitness or big beach balls. It is requested on children to observe the surface of them, close up and far away, so that they understand (especially on larger objects), that nearby, surface of spherical objects looks flat. So, we discuss about their observations in correspondence with spherical Earth, where surface looks flat but actually it is seen that way because we observe it from a very close distance.

Later on, children asked to recognize a map of their area and what is presented on it. With help of a computer, we can identify the same map in Google Earth and zoom out, in order that the roundness of Earth is recognized (because of the two dimensional computer screen). Then, we arrive at the presentation of the globe, which has similar form with the one we met on computer screen, but with one more dimension, which shows the sphericity of Earth. It is important to recognize their area, realizing that we are constantly seeing the same area, on the same Earth, avoiding a misconception in the existence of two different Earths. At the end of the first day, children would have come up with an initial visualization of Earth, where they are located.

Second day's activities start with viewing videos containing the first images recorded by astronauts, while moving away from Earth until they landed on Moon. The purpose of this cinematic experience is that children would realize that what they observed in models the previous day befalls in reality and is also recorded. Moreover, by viewing first astronauts' steps on Moon, children would notice that Moon and other celestial bodies are not as small, as seen in the night sky, but larger -like Earth- and are called planets. Remaining second day's activities will be developed in the extended presentation of our work.

Education of Roma children: Developing intercultural understanding and training skills for teachers through distance learning and a constructivist teaching model

By Christos Parthenis

This paper focuses on new developments in the science and technology of education and especially on distance learning as part of an educational programme at the University of Athens titled: Education of Roma Children. This specific project which started in 2010 has been extended geographically to a large part of the country, with the intention of addressing school based issues in preschool, primary and secondary education, and covering the entire period of implementation. The development and implementation of the above programme has been administered by the University of Athens and the Ministry of Education. During the school period 2010-2013, its nine basic actions had provided assistance to 1060 schools benefiting about 25.000 pupils. The programme is to continue its successful course for the school year 2013-2014.

With regard to the interventions at school units, planning involves actions related to the increased enrollment of Roma children and their continuation. The achievement of these goals was accomplished through the training of teachers (Action 4). Action 4 titled In Service Training for teachers, is one of its basic actions and distance learning is the Sub-action 3 which is supported by numerous computer-based applications.
The specific Action and its sub-action are detailed as follows:

ACTION 4. IN-SERVICE TRAINING FOR TEACHERS aims at supporting and providing systematic in service training for teachers and contributes to direct support of the entire educational community in various pedagogical issues including interculturalism. Subsequent training of educational consultants, directors, teachers and teaching staff associated with the said school programme exists so that all active participants in the education cadre can help eliminate the negative stereotypes and reduce the refusal rate of Roma children as well as the reluctance of numerous teachers to accept Roma children in their classroom. The individual sub-actions concern: Sub-action 1, Sub-action 2 and Sub-action 3.

SUB-ACTION 3: DISTANCE LEARNING has supported both technically and operationally, and is related to the electronic distribution of materials. The organization of the educational material in electronic courses is a complex process. The support group of the project in collaboration with the development team of educational content has designed the structure of online courses and then uploaded the primary educational material to the appropriate subsystems of the platform.

The programme has designed and implemented training procedures that contributed to the enrichment of teachers in schools where Roma children were enrolled. The online courses that users can watch are related to the education of preschool teachers, primary and secondary school teachers.

Moreover, the training programmes of senior educators (educational consultants, directors, etc.) have been created and posted on the platform. The main purpose of their training is to enrich their skills in intercultural education and to utilize theories, methods and means of implementation of the teaching-learning process on Roma pupils through a reflective methodology and a dialectical approach of teaching.

Additionally, the user can attend training courses related to issues of integration of Roma children in school, acceptance of diversity, strategies for addressing psychosocial problems and behaviour problems of pupils, etc.

Finally, we would like to emphasize that the teaching models of electronic courses were based particularly on a constructivist teaching model whose aspects are the group cooperation method and the project method.

Preschool and elementary school children ability to attribute theoretical mental representations to other in a science context

By Michel Bélanger, Julie Mélançon

Theory of mind is a field of study in developmental psychology seeking to understand the emergence of children's ability to attribute to other people mental representations that are different from their own and to use them during inferences. The consensus among researchers is that this ability is generally acquired around 4 or 5 years of age. It is admitted that its development certainly continues after this age, however few studies have been conducted beyond preschool level. From our perspective, the elementary school level, more specifically a learning science context, may generate new investigations about theory of mind development.

In this study, we explored the ability of children to attribute theoretical mental representations to other and to use them during inference tasks. Classical tasks in the theory of mind field focus on what we call factual mental representations (e.g., location of an object, content of a box, etc.). In order to increase the relevance for science education, we constructed a task involving the attribution of theoretical representations to other people. By theoretical mental representation, we refer to a representation that differs at a definitional (ontological) level and/or a causal level from the representation the child himself possesses.

More specifically, we presented children a story of a child, Cloé, talking to his cousin about what it takes to be an animal, making sure that the criteria used in the story were different than those the child use himself. After telling the story, we submitted the child an inference task: we ask him to tell us if specific new items (i.e., a frog) would be classed as animal or not according to Cloé, and why so. Some items were chosen as to be classed differently by the child and Cloé, in order to see if the child could inhibit his own representation and answer the question like Cloé would have. Other items were chosen as to be classed the same by both the child and Cloé, in order to see if the child could refer in his justification to the theoretical standpoint of Cloé even if both their answers were the same.

In order to determine when most children succeed in doing this attribution of theoretical mental representations, we submitted the task to approximately 50 children for each level from preschool to 4th grade. Preliminary results seem to indicate that the task is succeeded by the majority of children in 2nd or 3rd grade. These results would thus support the assertion that mental representation attribution ability gains in power during elementary school.

A better understanding of the development of this ability is of importance for elementary science teaching since it is a priori involved in science class discussions,

which are often present in science inquiry approaches and conceptual change teaching strategies.

Learning science in a collaborative and technological environment

By Éric Durocher

Schools sometimes have to address many contemporary challenges simultaneously. In the Quebec province (Canada), a new competency-based state curriculum in science and technology, the integration of ICT and new collaborative pedagogical methods are some of these challenges to be addressed. This situation leads us to radically reconsider the way we design learning environments and select our teaching methods. That is the conclusion that was made at Dalbé-Viau High School (Québec), and led us to design a collaborative educational learning environment called PEAi.

For three years now, Dalbé-Viau High School designs and develops, improves and sustains such learning environments that are based on collaboration among high school students. Each of these classes contain six interactive whiteboards facing work islands of 4 or 5 students with a laptop for each.

Learning science is done through challenges, problems and projects. To adress these challenges and solve these problems, students use computer tools that are at their disposal (computers, interactive whiteboards, the Internet, cameras, etc.) and through discussion and interaction. This collaboration between team members is however the central characteristic of the learning environment. Indeed, it allows them to confront their initial conceptions and produce the uncertainty that is needed for learning and for the validation of their understanding.

In this talk, we will present the PEAi, the origin of the project, the teaching methods used by the teachers of these classes as well as the challenges that come with such learning environments.

New Technologies in Science and Technology Education Sessions

Thursday 29 May 16:00– 17:00

Technology and Teachers in Greece: Attitudes towards e-government

By John I. Karavasilis

Nowadays there is vivid interest for e-government worldwide. Governments' investment in information technology and e-government have evolved in order to increase the quality and efficiency of internal government operations, deliver better public services, facilitate administrative and institutional reform, and engage government's customers in the decision-making processes. However, governments' are driving their development agenda and investments in e-services, based on their understanding of what are their customers' needs and without measuring what increases customers' willingness to adopt the offered e-services. Teachers are internal customers of e-government. The development of effective internal customer e-services can fundamentally transform the quality of their working life, reconstruct communication and coordination and would have a consequent positive impact on productivity. A fundamental question that arises is what are the factors that determine the adoption of educational e-government websites by teachers of primary and secondary education in Greece? Using an online survey four hundred thirty nine teachers' opinions and attitudes were recorded. Findings reveal that cognitive and intrinsic factors have significant effects on intentions to use e-government websites. Perceived risk, trust in e-government services, relative advantage, compatibility, personal innovativeness, image and subjective norm along with perceived use of use and perceived usefulness of offered e-services are the main factors that determine the adoption of educational e-government websites. Thus, the teacher-user should be placed at the center of future developments. The findings give some clues and directions for planning effective e-government practices and could assist policy-makers with the first guidelines about which areas should be improved in order to enhance e-government services.

Friday 30 May 17:40– 19:20

Teaching the Phases of the Moon and the Seasons in a Digital Planetarium

By Pierre Chastenay

More and more planetaria worldwide are turning digital, with ultra-fast computers, powerful graphic cards, and high-resolution video projectors generating highly realistic astronomical imagery in real-time. With this technological upgrade comes the possibility to show audience different perspectives on astronomical phenomena, geocentric (the view from Earth) as well as allocentric (the view from space). This, coupled with the total immersion provided by the planetarium dome, offers a new way to teach

astronomy, especially topics that are inherently three-dimensional and require, to be understood, that the learner sees the phenomenon from different points of view. The phases of the Moon and the seasons are good examples of such highly three-dimensional astronomical phenomena, and like other virtual reality environments, the digital, immersive planetarium can help learners construct mental models that are in congruence with the scientific views on these topics. In the present study, a digital planetarium was used to teach the phases of the Moon to children 12-14 years old. The phases of the Moon are a phenomenon that can only be understood if one can see the Moon from space, revolving around the Earth, with its lit hemisphere always facing the Sun, but seen at varying angles from Earth, and reconcile this view with the geocentric perspective on the changing aspect of our satellite over one month. The digital planetarium can provide both the geocentric and the allocentric point of view on lunar phases. Using a Design Experiment approach, we were able to document the reactions of six children aged 12-14 years old as they experienced the first implementation of an educational scenario to teach lunar phases in a digital, allocentric planetarium. By collecting qualitative data on their conceptions of lunar phases before, during and after the intervention, using various instruments (questionnaire, interviews, pictures sorting and modeling), we were able to show conceptual evolution in five out of six participants, with four of them being able to articulate the scientific explanation for lunar phases in their own words and by using concrete models to demonstrate it. After presenting these results, we will also present preliminary results of the first implementation of an educational scenario to teach the seasons to children 10-12 years old, using a similar digital planetarium and collecting qualitative data before, during and after the intervention to show the evolution of participants' conceptions about seasons. The implications of these two studies for the teaching of three-dimensional astronomical phenomena will be discussed, as well as directions for future research using the digital, fulldome planetarium as a teaching tool in astronomy.

The place of the instrument in the analysis of learning interactions

By Rodica Ailincai, François-Xavier Bernard

Nowadays, a significant number of learning situations widely involve the use of IT environments regardless of the nature of the educational setting in which they are realized: that is either within the formal educational context (provided by teachers), or in the home environment (provided by parents). The use of computers, educational software or other technological instruments, change the nature of exchanges, between students and teachers or children and parents. We are concerned with the analysis of the interactional dynamics of learning activities using new technologies. We, therefore, are interested in interaction analysis models that take into account the instrument.
In our study, we made use of four interaction analysis models that inspired each other. Rabardel (1995), considering the importance of taking into account the artifact in instrumented activity situations offered the ternary model Instrumented Activity Situations (IAS). Rézeau (2001) in his PhD thesis, using Rabardel's IAS model, as a starting point, and Houssaye's (1985) teaching triangle, developed a new model. Rézeau's teaching square included four determinants "Teacher, Learner, Knowledge, and Instrument". The latter model was taken by Bernard (2006), who by adapting it to dyadic learning situations (tutor, child, instrument, knowledge) in a museum setting, designed the Media Square Model, a dynamic analysis model of interactive and interactional situations. Ailincai (2010), in her turn, adapted the model to complex learning situations such as classroom interactions or interactions in family settings

where an instrument is used and called her model the KITLoK model (Knowledge, Instrument, Tutor, Learner, other Knowledge).

In this article we will first present the aforementioned analysis models succinctly, and in the second part of our paper, we will focus on the KITLoK model which was used during an exploratory study concerning 15 years old alloglote pupils during a debate in a collaborative learning environment using a computer, in French Guiana. This study questions the place of the technological instruments and their impact in the specific educational context of isolated sites in French Guiana where students have little contact and familiarity with the technology (e.g. the internet). Favoring an ecological and interactionist approach, the study provides descriptions of situations from the point of view of the influence of the instrument (computer software) on the interactional dynamics as well as the quality of discussions as regard learning. Finally, linguistic and cultural variables will be discussed during the interpretation of results.

Designing and Implementing Experimental Microcomputer-Based Activities by Primary Student Teachers

By Dimitris Stavrou, Vasilis Savvorginakis

In this work sixteen primary student teachers' abilities and difficulties to develop microcomputer-based experiments and integrate them in an inquiry approach in order to teach basic science concepts and phenomena to primary school students is presented. The design of the study was as follows: a) primary student teachers in groups of two chose a particular scientific subject area (e.g. mechanics, thermodynamics), they developed experimental activities using equipment manufactured by PASCO (http://www.pasco.com) and they integrated them into an inquiry based approach. b) primary school students carried out the designed experiments under the supervision of the student teachers.

Education of Roma children: A multidimensional programme which stresses the importance of supporting networking of schools and all active participants through web applications and social media

By Christos Parthenis, Eirini Tseliou, Aikaterini Tsoka

This paper focuses on new developments in the science and technology of education as part of an educational programme at the University of Athens titled: Education of Roma Children. This specific project started in 2010 with numerous interventions in schools with the aim of benefiting Roma children as well as indigenous students. The Programme focuses on the realities of school integration, educational exclusion, school failure and the drop out rate of Roma children throughout its actions. By the school period 2012-2013, its nine basic actions had provided assistance to 1060 schools benefiting about 25.000 students. The programme is to continue its successful course for the school year 2013-2014.

Action 4 and Action 7 are the two basic actions of the program backed by numerous computer-based applications.

ACTION 4. IN-SERVICE TRAINING FOR TEACHERS:
This action aims at supporting and providing systematic in service training for teachers and contributes to direct support of the entire educational community in various pedagogical issues including interculturalism. Subsequent training of educational consultants, directors, teachers and teaching staff associated with the said school programme exists so that all active participants in the education cadre can help eliminate the negative stereotypes and reduce the refusal rate of Roma children as well as the reluctance of numerous teachers to accept Roma children in their classroom. The individual sub-actions concern: Sub-action 1, Sub-action 2 and Sub-action 3.
The SUB-ACTION 3: Distance learning, supported both technically and operationally, and related to the electronic distribution of materials and the organization of e-classes.

ACTION 7. NETWORKING OF SCHOOLS:
The school networking of the programme offers partner schools access and active participation in the material, activities and results of the programme. Networking of schools is about using information and communication technologies in education for the construction, planning and elaboration of a website to present the Program's application data. Our goal is to create an interactive map to present Roma settlements and Roma camps affected by the project as well as to plan and set the parameters of social networking (Facebook site, YouTube channel, Twitter). Moreover, this service assists by reinforcing communication and cooperation in order to upload digital educational material and give information on actions and events regarding the project and download data such as notices, announcements, user groups, school networking units, network of associates, areas of discussion, positive practices and other related matters.

The administrative and evaluation process of the programme has been extended geographically to a large part of Greece with the view to addressing school based issues in preschool, primary and secondary education. The regions of the Program are: Attica, Central Greece, the Southern Aegean, the Peloponnese, Crete, the Northern Aegean, the Ionian Islands, Thessaly, Epirus, and Western Greece. Therefore, the creation of Web Applications has facilitated communication among the associates of the partner universities. Web application tools are now in use by the Program's collaborators and user groups as a useful tool for information, solutions, efficiency and positive practices.
In web applications, the total quantitative data of all intrusive measures are incorporated into the tables, parallel to the description of each programme action. Their results concern the accumulated data so far. At the same time, the coordinators of the project can enter the cooperative networking region with access to the following links in order to record their daily activities in diary form.

Finally, despite the theoretical context of the paper, the power point presentation is to reflect the two basic actions associated with technology in education and the web applications of the Programme.

Multimedia applications by using video recorded experiments for teaching Biology in secondary education

By Dokopoulou M., Bozas E., Pavlatou E.A

The rapid development of information and communication technologies (ICT) provides a significant number of tools and techniques that help developing educational applications on a user-friendly interface. These applications enrich the teaching -

learning processes by creating learning environments that facilitate students' interest and active participation. Biology teachers are in line with the main stream in induction of ICT into teaching routine and also there is a positive correlation with the use and availability of computers only if they are located in a biology classroom or a laboratory. A simple school experiment significantly strengthens its cognitive and motivational role in science education at secondary schools. On the other hand, teaching Biology in a laboratory is often difficult due to lack of equipment, limiting school time and increased number of students in the class. Video recording of a school experiment might be one of the possible solutions in this situation as it could be applied into all teaching phases. In this paper we present multimedia applications which are going to be used for the enrichment of Biology e-textbooks in secondary education and are uploaded in the "Digital School" platform which is the official platform for educational material of the Greek Ministry of Education. The common characteristic of these specific applications is that they use recorded videos of rather simple experiments realised in a biology laboratory. In particular, these videos are designed in such a way in order to supply to students with the basic information of using a microscope, observing nucleus from plant cells, isolating nucleic acids from human cells, studying mitosis and protein denaturation. Each one of these videos is a part of a multimedia and interactive application which uses texts, images and tests. In this way they potentially enhance both the practical and theoretical aspects of science. They also help teacher to manage time consuming processes like the preparation of laboratory equipment and give class time to think, discus and reflect through the immediate visual feedback. It is expected that these applications will offer every student and teacher free access to the above material promoting open knowledge of Biology.

Recognizing Interesting Points in Constructionist Activities Using Artificial Intelligence

By Marios Xenos, Chronis Kynigos, Maria Daskolia

This paper addresses the potential of using Artificial Intelligence technology to support educational processes of classroom-based constructionist collaborative activities. Within the context of the Metafora Project a half-baked microworld called Sus-City which was constructed to assist teaching and learning processes within the field of Environmental Education was redesigned to provide real time recorded data on user interaction. The recorded actions are analysed with the aim to provide meaningful information about the progress of the activity as well as to indicate points in which tools could assist the students' learning.

Multi-Agent Models, made in NetLogo, for teaching simple properties of Complex natural systems, and their instructional use

By Aristotelis Gkiolmas, Maria Papaconstantinou, Anthimos Chalkidis, Constantine Skordoulis

NetLogo is a modeling, simulation and programming environment used worldwide to model and teach about natural systems. In this research, NetLogo Models, taken from the Models' Library of NetLogo, were utilized as teaching tools, in order to carry out instruction about specific properties of Natural systems and ecosystems, focusing

mainly on Critical behavior. Then a teaching sequence was created, based on Constructionistm, and using an Inquiry-based-learning methodology, and the above-mentioned Models of NetLogo as the instructional tool, to create a case study, in order to teach future Greek Primary School teachers, about those properties. The results of the case study have shown acceptable learning outcomes. Additional measuring criteria for the Complex (natural) Systems' understanding and learning were used, as: (i) the Structure-Behavior-Function (SBF) characteristics, and (ii) the "novice's" vs. "expert's" in Complex Systems juxtaposition.

Assessment in Science and Technology Education Sessions

Friday 30 May 18:40– 19:20

Assessing Students' Knowledge on Refraction

By Claudia Haagen, Sebastian Glantschnig

Optical phenomena are part of our everyday life. Nevertheless, students find it even after basic instruction in optics difficult to explain everyday optical phenomena with the help of scientific concepts. Alternative conceptions which are frequently not in line with scientific sound concepts are used in the majority of cases to explain phenomena. These alternative conceptions use to be persistent as they are mostly deduced from everyday experience. The identification of such alternative conceptions is one of the most important prerequisite for promoting conceptual change.

At the Austrian Educational Competence Centre of the University at Vienna currently instruments for assessing such students' alternative conceptions in different subtopics of basic geometrical are developed. One objective of this project is to develop a multiple-choice test which is able to portray student's conceptual knowledge base in a reliable way. The form of items used for this test instrument is two-tier items: The first part of the item is a multiple-choice item that includes responses with known student alternative conceptions. In the second part of each item, students have to justify the choice made in step one by choosing among several given reasons.

An already existing version of a two-tier multiple-choice instrument did not contain two tiered test items on the topic of refraction. The contribution reports on the development of two-tier test-items on the topic of refraction – including image formation with converging lenses. The main aim was to improve already existing one-tier items on refraction and add a reliable second tier. Firstly, open questionnaires (N=131) were administered in year 8 classes after their basic instruction in optics. The analysis of the open answers served as basis for distractors for the second tier of the items. Additionally, qualitative interviews were led to validate and improve the distractors found with the help of the open questionnaires.

The contribution reports the process of item development. A special focus is put on the qualitative interviews which also allow deep insight into students' conceptual knowledge base on refraction. Finally, the final version of the two-tier items on refraction is presented and discussed.

Tracing Computer Assisted Assessment for learning Capability in Greek Teachers

By Zacharoula Smyrnaiou, Evangelia Petropoulou, Eleni Spinou, Kathrin Otrel Cass

During the last decade within the context of educational reforms carried out in various countries around the world there has been a tendency to focus on the assessment practices implemented by teachers as a key factor in shaping the quality of education. So far, assessment has been mainly accumulative and generally conceived as an end to itself. Due to the adoption of updated pedagogical theories, a change of focus was triggered from assessment for acquisition of knowledge/learning (assessment of learning) to assessment of the effective implementation of skills in various environments (assessment for learning), thus putting emphasis on the cognitive procedure rather than the outcome. However, according to a critical consideration of the application of the instituted student assessment, assessment practices remain traditional. This inconsistency of reform with regard to the application of the formative assessment model triggered our research study.

In the context of our research effort we are involved together with other four universities in the 'Tracing Assessment for learning Capability in Teachers' (TACT) project, aiming to investigate how student teacher candidates develop and construct ‘assessment literacy 'over the course of their teacher education programme and into the first one / two years of their classroom practice as beginning teachers. The research tool selected for the specific study was a questionnaire due to be addressed to first year students in order to evaluate their primary beliefs about assessment and provide us with an insight across the levels that shape and influence teacher assessment practice. This questionnaire constituted a translation of one applied at an earlier study in New Zealand during the ‘Learning to become ‘assessment capable' teachers’ project. However, there was a need for certain modifications in order for our questionnaire to accurately and precisely address the existing conditions of the Greek educational system. By the same token, the Greek research team has chosen to use a web- based questionnaire, including tools and questions concerning Computer Assisted Assessment (CAA). This decision was based on the fact that the use of ICT tools in education has been increasingly used with considerable benefits for the learning process. Thus, CAA appears to be an innovative and reliable form of assessment, enhancing the possibilities of validity, adjustment, and continuous improvement of the assessment procedure.

In the pilot phase of the research student teacher candidates, beginning teachers as well as more experienced teachers have participated in the completion of the questionnaire providing us with results which indicate that student teacher candidates and beginning teachers’ beliefs about assessment remain close to the beliefs of students as recipients of assessment, whereas more experienced teachers have managed to shift their perspective to the point of view of the educator who implements assessment in order to mediate learning successfully.

Teaching and Learning in the light of Inquiry Learning Methods Sessions

Saturday 31 May 09:00 – 10:20

New competences to develop in students to help them get involved in sustainable development

By Diane Pruneau, Jackie Kerry, Joanne Langis

The sustainability competences field was established because of current complex problems: climate change, desertification, pandemics... These interdependent, contradictory and urgent problems, located in changing landscapes and demonstrating high damage potential, do not have immediate solutions. To solve problems, to take advantage of opportunities, to become agents of change and managers of a society in transition, learners should develop key competences in sustainability. These competences are cognitive, affective and motivational capacities that allow citizens to make changes in current economic, ecological and social practices without these changes necessarily being a reaction to existing problems. The key sustainability competences are those that allow citizens to understand the challenges faced by society today and to facilitate development towards a sustainable future. It's a matter of educating agents of change, able to contribute to the necessary modifications for an economy using less energy and resources while strong in intellectual capital, in creativity and in collaborative work.

In sustainability science, a discipline that resembles environmental science but that includes the cultural and social aspects of problems, researchers recommend the development of many key competences. These competences, linked to complex problems analysis and societal transformation, are: critical thinking, creativity, solving complex problems, adaptability, communication, cultural competences, systemic thinking, futures thinking, risk prediction, planning, strategic action, ecological awareness and knowledge on sustainability.

The analysis of the Canadian science and technology curricula highlights two common pedagogical approaches: inquiry and technological problem solving. Some sustainability competences feature among the analysed science programs' objectives: problem solving, communication, critical thinking, team work, and creativity. Other competences could advantageously be added: cultural competences, strategic action, systemic thinking and futures thinking. Training on sustainability competences could be added in the two basic processes of the Canadian science and technology curricula. For example, during the inquiry process, at the stage of posing the problem, systemic thinking and cultural competences could be encouraged by inviting students to consider the problem as a whole, in an interdisciplinary way and according to various cultural points of view. They could also be invited to create links between elements of the problem. At the stage of defining the problem, it would be a good time to ask students to invent various scenarios of the future in connection with the problem so as to develop futures thinking and risk prediction. An action component to improve the studied problem could be added to the

inquiry process allowing the use of planning and strategic action competences. Ideas to integrate training on sustainability competences are also possible in the technological problem solving process.

Development of argumentation skills through a web-based learning environment devoted to 'Antimicrobial Resistance'

By Scholinaki, A., Constantinou, C.P., Siakidou, E., Koursaris, D.

Effective learning in the Sciences is analysed into several constituent components, including conceptual understanding, scientific skills, reasoning strategies and epistemological awareness. Argumentation falls under reasoning strategies and refers to the development of the ability to formulate evidence-based claims and to evaluate arguments constructed by others. Argumentation has a central role in science; scientists use arguments to build their case, to counteract other scientists' claims and also to refute alternative hypotheses. In recent years, argumentation has received increased attention by researchers in science education as one way to involve students in authentic tasks that characterise scientific practice and as a vital skill for citizenship. However, argumentation is rarely the focus of attention in science classrooms, even though empirical studies have shown that argumentation skills do not emerge spontaneously and require systematic engagement. Furthermore, engagement in argumentation processes is believed to help students develop conceptual understanding and understanding of the nature of science.

The focus of this paper is on the design, development, research validation and refinement of an on-line inquiry-based learning environment that aims to promote, in an integrated manner, argumentation skills and conceptual understanding. The learning environment features the topical socioscientific issue of Antimicrobial Resistance. Apart from being an issue of great importance to the whole community, antimicrobial resistance offers the advantage of covering a wide range of biology concepts included in most secondary education curricula, such as microorganisms, immune system, antibiotics, natural selection and others. The designed learning environment contains authentic data that need to be processed and synthesised by the students in order to formulate valid arguments. The learning environment has been implemented twice in real classroom settings. The subjects were eighty high school students. This paper describes the development and refinement process of the learning environment and reports on preliminary findings about the learning outcomes.

Approaches of Inquiry Based Science Education in Secondary education in Greece

By Kallia Katsampoxaki-Hodgetts, Maria Fouskaki, Katy Siakavara, Nikos Chaniotakis

National Science education reform initiatives stress the need of steering away from the traditional teacher-centered mode of instruction when it comes to science education. This study is part of a three-year project Chain Reaction, funded by the European Commission, investigating the approaches, applications and implications of a sustainable Inquiry Based Science Education (IBSE) framework across twelve partner

countries. The purpose of this paper is to provide information on how this innovative project was integrated in five Greek Secondary Schools of Crete, and to explore the perceptions of all stakeholders: management, teacher educators, teachers and students. Five schools, ten teachers, and one hundred and fifty students aged 14-16 took part in this project in the first year. Qualitative methods were used to analyze data and identify all stakeholders' views by the Laboratory of Analytical Chemistry at the University of Crete. It is indicated that as long as this project is tailored to each partner's individual cultural and curricular needs, all stakeholders had a positive experience which constitutes IBSE as an optimal learning mode with positive contribution to the educational process.

CREAT-IT: Implementing Creative strategies into Science Teaching

By Anna Craft, Oded Ben Horin, Menelaos Sotiriou, Petros Stergiopoulos, Sofoklis Sotiriou, Kerry Chappell, Sarah Hennessy, Dobrivoje Lale Eric, Cinzia Belmonte

For teachers, creativity and innovation is a high-risk activity and the incentives are few (Hannon, 2009). In a system where the center has been the innovator, practitioners' compliance understandably becomes the habit. The dynamic of change in education in Europe has been described in terms of a set of shifts, first, from "uninformed prescription" (in the 1980s); to "informed prescription"; then towards practitioner led change (Barber, 2002). This last was seen as the key to self-sustaining, rapid improvement. It is within this context, that the CREATIT project is taking forward the agenda of practitioner led change at a European level by introducing creativity in science education. At the level of individual teachers this implies getting three things to happen:

Individual teachers need to become aware of specific weaknesses in their own practice. In most cases, this not only involves building an awareness of what they do but the mindset underlying it.

Individual teachers need to be motivated to make necessary improvements. In general this requires a deeper change in motivation that cannot be achieved through changing material incentives. Such changes come about when teachers have high expectations, a shared sense of purpose, and above all, a collective belief in their common ability to make a difference to the education of the children they serve.

Individual teachers need to gain understanding of specific best practices. In general, this can only be achieved through training and demonstration of such practices in authentic settings.

Openness of the school environment and the enhancement of teacher skills, strengthening their ability to motivate innovation and creativity is crucial. Creativity with a capital "C", the kind which changes the way we see or understand the world, never occurs on its own, but rather as part of an encouraging system. It is precisely the enrichment of the creative elements in Science Education as an integral part of such a system, based on a wealth of existing European knowledge, which is the cornerstone of the CREATIT project. The project focuses on late primary and early secondary teachers' –in-service- training by implementing teaching practices in which the integration of science education and other creative disciplines in formal education systems construct the CREATIT Pedagogical framework.

CREATIT project develops and supports teacher skills in science education by integrating creative, cultural disciplines and social media tools in science courses, engaging students to participate in collaborative, project and case study based activities. In these activities teachers and students are involved in collaborative and dialogue activities (Science Cafes), cultural, artistic and role playing activities (write science theaters and science operas) totally connected with their science curriculum.

Saturday 31 May 16:20 – 17:40

The PATHWAY to inquiry-based teaching – An European perspective

By Bogner Franz X., Sotiriou, S.

The PATHWAY framework follows a concise methodology for designing, expressing and representing inquiry-based educational practices. This allows, first, the mean for describing the identified Activities for Teaching science by Inquiry, that is, the building blocks of different scenarios which are identified as subject-domain independent "educational activities" that implement a specific inquiry educational approach, second, to either properly implement existing Best Practice Educational Scenarios from international success stories or to create new Activities for Teaching science by Inquiry. All these activities follow three main categories: school based activities, activities that promote school-science centre and museum collaboration and activities that promote school-research centre collaboration.

Emerging Pedagogies and New Technologies in Science Education

By Yvonne Crotty, Margaret Farren, Martin Owen

This paper will provide a background to our current research work in the context of the European project, 'Inspiring Science' which builds on our earlier EU project 'Pathway to Inquiry Based Science Education'. The national situation with regard to science education in Ireland will be described. We will present feedback from a sample of post-primary science teachers on inquiry based science education (IBSE) and the use of virtual learning environments (VLE's). Finally we will discuss our contribution to the 'Inspiring Science' project which will involve the design, development and implementation of an online Continuing Professional Development (CPD) modules for post-primary science teachers in Ireland.

Improvement of a Complex Technology-Enhanced Learning Environment

By Margus Pedaste, Külli Kori, Mario Mäeots

Science and mathematics education is named as key facilitator in achieving innovation in the European Union. However, in this case there is a need to change the learning methods to be more engaging – to apply inquiry and problem solving methods. In Estonia these approaches have been applied through pre- and in-service teacher

education, changes in national curricula and development of technology-enhanced learning environments for more than 10 years. It could be seen as one of the reasons why Estonia has very good outcomes according to international PISA tests and why these have been significantly improved during the last years.

In general it has been demonstrated that inquiry learning is effective in comparison with more 'traditional' learning approaches like direct instruction or open discovery. However, it is not often applied worldwide in schools while it is not easy to change teachers' attitudes towards inquiry that is often time-consuming and unpredictable. Therefore, we have developed several learning environments that can be applied by the students with only minimal help of teachers. In this case technology enhances students' inquiry process even if their teachers do not. One of the main issues in applying these learning environments is their complexity. In the current study we were interested how a complex technology-enhanced learning environment can be applied to improve students' inquiry knowledge and skills.

In our study we used a learning environment SCY-Lab, which is a complex technology-enhanced learning environment where students complete different missions. On these missions they apply a specific learning scenario, e.g. inquiry based learning scenario in the learning module applied in our study. On this mission students solve a problem using inquiry approach. They formulate research questions and hypotheses, read theory about their topic, plan an experiment, collect data and analyse it, make inferences and conclusions. Students' learning is supported by several tools and scaffolds and in specific activities peers' support can be given. This learning environment was developed in the context of a European project to meet the needs in many countries.

A SCY-Lab mission in ecology was applied by four schools in Estonia. The mission was completed by 54 students (aged 14-18) who filled in pre- and post-questionnaires for describing their general inquiry knowledge, transformative inquiry skills and domain-related knowledge. In addition, students' reflection of inquiry was guided in the learning environment by specific supportive questions. Thus guided inquiry and reflection were seen as the main factors supporting students' inquiry process.

The results of the study showed that students' general inquiry knowledge, transformative inquiry skills and domain-related knowledge improved statistically significantly in applying SCY learning environment. The level of general inquiry knowledge correlated positively with domain-related knowledge and transformative inquiry skills. It could demonstrate that general inquiry knowledge is needed to activate meta-processes as it is described according to a model of inquiry. In addition, it was found that the learning gain of knowledge and skills is the higher the lower it is in the beginning of the learning process. Thus, the SCY-Lab ecology mission seems to support inquiry even if the initial knowledge and skills of students are not very high. A reason for this could be the active reflection of inquiry. According to the analysis on reflective activities most of the students say that the analysis of their learning process is an important activity, analyse their inquiry and consider alternative solutions for their inquiry after the process in order to learn from experiences.

In conclusion, ecology mission in the SCY-Lab learning environment seems to be a good example for understanding how a complex technology-enhanced learning environment should be designed.

Patternization of the design process applied for the construction of a structurally sound educational tool: The paradigm of a secondary development tool negotiating scientific concepts

By Zacharoula Smyrnaiou, Liana Petropoulou, Maria Margoudi, Ioannis Kostikas

The new generation of educational tools, based exclusively on easily accessible open source software in order to permit and enhance the user's designing intervention, has enriched the teacher's role with the quality of a designer of targeted –in terms of negotiating cognitive concepts - artifacts. The genesis of such targeted artifacts is subject to dynamic multilevel negotiations informed by pedagogical theories and practices but also rooted in deep understanding of the cognitive subject under negotiation, which is directly dependent on the selection of the instrumental 'generator' for the design of a secondary computing environment. Although many studies have been carried out with a main focus on the use and the targeted selection -in terms of pedagogy- of effective educational tools, there is a lack of information on the design process followed by each designer as well as an analysis of the influences governing his decisions - both overall and partly - during the design process.

This research study based on the methodology of design-based research examines and explores the design process followed by a student teacher candidate during the creation of a Microworld –as a secondary development tool- that negotiates scientific concepts related to the cognitive module of Kinematics and Dynamics in Physics. Based on the gathered data, the design process was approached through the definition of two control filters: a) the circular sections of the TPACK frame (Pedagogical Content Knowledge, Technological Knowledge and Technological Pedagogical Content Knowledge) as determining components for an effective learning process and b) the Cognitive schematization frame (COSC) which allows us to explore the dynamic interaction between the designer's available resources and the resources provided by the digital system during their bidirectional cross - adaptation and mutual extensibility. The validity and reliability of the study is ensured with the application of the cross analysis technique that allows us to examine the data both vertically and horizontally. The division of artifacts in three design stages (Initial, Middle, Completion Stage) enabled us to record the dominating design tendencies, in sequential order, as well as to explore the impact of these tendencies on determining the final result. The aim of our research is to make an explicit analysis on the way the design process can be represented in a format, perceived as a pattern, which will eventually inform stakeholders on the design specifications that should be followed, perceived as a benchmark and verification of a design process.

Neuroscience and Science Education Sessions

Thursday 29 May 19:00-19:20

The Making of an Educational Neuroscience Opera

By Oded Ben-Horin

The Neuroscience Rosetta Stone is explained by Susan Greenfield to be a system of matching our senses of consciousness, and what we feel, with what happens physically in the brain. Yet at present there are no obvious clues as to what that system might be. This presentation describe the creation of the educational neuroscience opera Rosetta's Stone, which takes its thematic and character inspiration, design and structure from neuroscience phenomena such as various brain regions, neuronal assemblies, and the roles of creativity and music in treatment of neurodegenerative disease. The opera will be discussed as a qualitative, artistic research tool aimed at learning more about the borderline between our physical, conscious and emotional minds in educational and other contexts. Both professional artwork will be presented as well as visual artworks by pupils of the Bergen Culture School in Norway.

Saturday 31 May 09:00 – 10:20

A Study of Affect and Cognition in Tutor-supported Collaborative Learning in Physics

By Julien Mercier, Patrick Charland, Dave Saint-Amour, Line Laplante, Martin Riopel, Steve Masson, Vivek Venkatesh

This presentation is about instituting a novel program of research suggesting a new branch of educational neuroscience concerned with the study of social modes of learning. The gain of this approach, which involves superimposing psychophysiological data with behavioral data, is a much richer record of affective and cognitive processes, with a better temporal resolution and which includes information that cannot be easily verbalized or that would disrupt the natural course of action if obtained otherwise (through self-reports for example). In previous work and pilot studies, we borrowed from diverse disciplines including education, educational psychology, cognitive psychology, affective and cognitive neuroscience, social neuroscience and work neuroergonomics to cumulatively establish a set of constructs important for learning and that could be measured in the context of this study. To date (this work continues), these constructs are attention, cognitive load, engagement, distraction, basic emotions, arousal, and pleasantness. Behavioral categories include feedback and scaffolding, problem solving, as well as collaboration. This approach is illustrated with a study currently in its first phases.

The objectives of the study are (1) to examine intra-individual and inter-individual affective and cognitive processes in dyads of undergraduate learners as they solve problems in physics; (2) to examine the impact of expert help on dyads' functioning and learning. A parametric sample of 35 dyads will be constituted so that the results can be generalized to the target population. First-year undergraduate student teachers in science education will volunteer in pairs or individually. Solitary volunteers will be grouped in pairs on the basis of schedule. The experimentation will take place at NeuroLab, a research facility under construction, which enables data collection bridging at the forefront how cognition and emotions interact dynamically during the performance of a learning task. NeuroLab's unique potential is the integration of psychophysiological and behavioral data collection equipment in two participants within simulations of ecologically-valid educational settings. After taking an initial knowledge test individually, dyads will be asked to solve a series of 10 physics problems in collaboration. Those problems will be designed to be too difficult to be solved without help from a more knowledgeable peer or coach. The coach will be a Ph.D. student in physics, trained in specific modes of tutoring (scaffolding and feedback) validated by research. Globally, the findings of the proposed study should help refine learning environments involving learners, instructors, and learning software. Results should contribute to an unprecedented characterization of affective and cognitive dispositions conducive to learning, which are transitioning much more rapidly than usually measured by extant research during learning efforts. New insights into how cognitive and affective functioning of individuals affect cooperation and learning in dyads during learning efforts should also be gained. Finally, results should inform how moment-by-moment instantiations of specific modes of scaffolding and feedback influence affective and cognitive functioning of learners at the individual, inter-individual, and dyad levels. These results should contribute to the empowerment of learners and instructors by providing them with enhanced tools and methods to monitor and regulate cognitive and affective states so that states detrimental to learning transition to states conducive to learning, and that states conducive to learning are maintained. This study should also add to basic research regarding the mapping of relationships between the psychophysiological, cognitive (in the sense of conscious processing of information and affect) and social aspects of learning.

Integrating the perspective of neuroscience in tutoring research in physics: why and how?

By Julien Mercier

Despite inspiring insights into how to help someone learn physics, it is argued here that tutoring research may gain in overcoming the limitations of its main source of empirical data: behavioral observations. Data from think-aloud and conversation, logs of interaction with technology-enhanced learning environments, and tests capture important aspects of learning but definitely not all of them, leaving aside the transformation of knowledge elements over very brief periods of cognition. These limitations translate into the impossibility of tracking learning - conceptual change in particular - in sufficient details in order to provide better instructional prescriptions regarding being a good tutor and a good learner in the highly interactive learning environments implemented in science education worldwide. It is suggested that psychophysiological data is needed at this time to help resolve (re)current issues in this field. In this presentation, we present our view of the requirements for educational

neuroscience to make pertinent contributions to tutoring research in science education and we identify some of those expected contributions.

Available research point to a lack of information about the tutoring process, especially but not limited to the learner's state and the efficacy of tutor moves in relationship with changes in small units of knowledge. Indeed, four important questions remain largely unanswered by extant research: "what to scaffold, when to scaffold, how to scaffold, and when to fade scaffolding". These questions were originally formulated from a tutor perspective, but are also crucial when all or part of the responsibility of the interaction is in the hands of the tutee. Current issues will be discussed in conjunction with those four questions, with an overarching distinction between tutor agency (the "enhanced learning trace" issue) and tutee agency (the "enhanced metacognition" issue), especially with respect to which additional information can be provided to the protagonists using educational neuroscience methodology and the extent to which they can use this information productively.

To help resolve these issues in science education, a number of recommendations for the study of tutoring are suggested: (1) tutoring research in the context of science education may be a topic of choice to develop and test methodological paradigms in educational neuroscience because of the epistemic properties of this learning domain; (2) research problems should always be defined in behavioural terms and psychophysiological data should only be considered when significant additions to behavioral data can be expected; (3) experiments should involve many levels, including data associated with brain processes and data representing cognitive and interactive processes; (4) traditional behavioral tutoring research has to continue apart from the considerations of educational neuroscience, and the dynamism of the field indicates that cognitive methodology and concepts are likely to yield new insights about the optimization of learning interactions; (5) the notion of contingency, the moment-to-moment correspondence between the help provided and the learning needs of the tutee, seems to be under-researched and may be a rather fruitful notion to examine in studies integrating an educational neuroscience perspective, particularly in light of a sequential and multi-level view of learning; (6) psychophysiological data brings a focus on fast-occurring events, but a thorough study of tutoring involves the consideration of sequences of events over longer periods of time, and therefore the timespan of studies should be aligned with the time required for meaningful learning of specific notions in physics, as established empirically.

Brain activity during observation of affective pictures with scientific content

By G. K. Zacharis, A. Tsiara, P. Chalki, J. Vrellis, T. A. Mikropoulos

In the last two decades, a new field in educational research, that of educational neuroscience, emerges. According to educational neuroscience, under a biological basis and as a renovation of cognitive science in education, learning is defined as the process of "making neuronal connections in response to external environmental stimuli". Science education involves, among others, perception and orientation, visual and spatial perception, attentional demands, selection of objects and features, understanding of abstract concepts and models, spatial reflection of emotional and cognitive processes, information organization and processing, knowledge construction, metacognitive abilities, different cognitive styles. These cognitive processes can be detected through neuroimaging techniques and contribute to a better understanding of the environmental

stimuli used in science education. More effective learning environments could be designed and learning processes could be explained. Under this sense, this work presents the first neurophysiological results of students interacting with affective visual stimuli in a digital learning environment for earthquakes and other natural disasters. Fifteen adult women were asked to identify ten different images depicting non-semantic and semantic objects that they have to bring with them in case of an earthquake. The five semantic items were a cereal bar, a flashlight, a pocketknife, a whistle and a plastic bottle of water, while the non-semantic items were a hamburger, a bottle of milk, an ice cream, a laptop and a tool kit. The electric brain activity of 15 female students, 19 to 22 years old, was recorded and analyzed in the frequency domain by using Fast Fourier Transforms. The EEG signals in certain frequency bands were associated with various functional brain states. According to the EEG signals in the occipital lobe (electrodes O1 and O2), the participants recognized all the ten objects and showed visual awareness. The results from the prefrontal brain area (electrodes Fp1 and Fp2) in theta (4-7Hz) and alpha (8-13 Hz) frequency bands showed the appearance of mental effort. The differences in the EEG signals between the semantic and non-semantic images showed that the participants distinguished their meaning. These results indicate that brain activity can be used for the design of proper digital learning environments and the close relation of neuroscience with science education.

Art in the service of Science. A play about sleep mechanism: "Are we getting some sleep tonight or what?" Can a theatrical performance serve education and modify our habits? One year's experience

By Anastasios Bonakis

Brain is the most important organ in our body. Its constant ability to store information from the first hour of our life ensures our survival and wellbeing in a rather demanding environment. If vigilance is the state we gather information, sleep is the period that all that information will be stored as chronic memories that will follow us in our life. Especially those chronic memories that have stimulate our emotions, especially fear, they will serve the base of our dreams a potential mechanism of survival.

Since 2013 we have focused on effectively conveying valid scientific knowledge about sleep and its function to the public, particularly children and teenagers. Our aiming was to raise public awareness on health issues and especially sleep that affect personal and social well-being.

Searching ways in which medicine can contribute not only to effective diagnosis and treatment but predominantly to prevent ways of living and false sleep habits which affect our day function and finally our health, the collaboration of art and science is a challenge.

The production of an original theater play, about the function of the brain and the role of sleep in the human body, was realized in order to "explore" new effective ways to convey health-enhancing messages and “train” the public through entertaining activities.

Science theatre is probably a new tool on shifting people's behaviors towards healthier lifestyle choices.

Conceptual Understanding and Conceptual Change in Science and Technology Education Sessions

Saturday 31 May 16:20 – 17:40

Causality of magnetism: Development of a video-based intervention for primary students

By Vasiliki Spiliotopoulou, Christina Lianeri

This study aims to explore the role of a video based intervention on students' thinking about the cause of magnetism. Most research on students' conceptions in the area of magnetism is mainly at the secondary education level, while more recently the interest is shifted among university students. A few studies concern pre-school children's ideas and even less concern primary students' experiences. Most studies have focused on the analysis of students' conceptions with regard to specific aspects such as the interactions between magnets especially at primary school level, while few studies include in their analysis the concept of magnetic field.

Magnetic ideas are normally involved in the Greek primary curriculum of science. However, the emphasis is based on phenomenological aspects of magnetism and basic concepts as magnetic field sources and unifying model of magnets and electric current as sources of magnetic field are underestimated. Such concepts are essential in order to initiate students toward a scientific vision of electromagnetic phenomena. An intervention based on a specifically designed video has been developed in order to introduce the microscopic aspects of magnetism causality in primary students through narration. The main idea is that the movement of charges inside the atoms produces small magnetic fields, while the behaviour of these small magnets in its totality creates the phenomenon of magnetism as we experience in magnets. The video is not professional. It has been produced by one of the researchers, who is an experience primary teacher on the basis of a conceptual plan and the subsequent storyboard designed through the co-operation of the two researchers. The intervention has been applied to two 6th grade classrooms of public schools of Patras. Data have been collected through a number of questions concerning magnetism asked before and after the intervention (not all exactly the same). Particularly, the focus here is on the question "Do you know which the cause that creates magnetism is? Explain your thinking". 45 students participated and answered the question. Inductive qualitative content analysis has been employed for the analysis of students' written answers. For both the analysis of data and the presentation of findings the technique of systemic network has been used. The same systemic network is used for the analysis of the answers before and after the intervention.

Two main dimensions have been identified: causes related to the magnet itself and causes related to external factors. Across the first dimension two categories have been discerned: the first includes answers that attribute the cause of magnetism to macroscopic features of the magnet, revealing a way of thinking of magnetism as an

inherent feature of the magnet; the second category includes answers that connect magnetism to microscopic aspects that are further categorized in terms of their static or dynamic character. A detailed scheme of categories has been produced on the basis of which changes in students' descriptions are explored. Results show the impact of video narration on students' answers. Before the video-based intervention only two students involved microscopic ideas in their texts in explaining the cause of magnetism, while the majority of students discussed the causality of magnetism in microscopic terms after watching the video. A number of issues arose concerning students' use of microscopic ideas in relation to the co-deployment of visual representation and narration. Evidence from other questions enriches the findings concerning causality of magnetism and points to the potentiality of specifically designed videos in enhancing young students' experiences with in depth knowledge representations and explanations of scientific phenomena. Weaknesses of the video scenario and possible improvement are also discussed.

Using Physical and Virtual Manipulatives to Improve Primary School Students' Understanding of Concepts of Electric Circuits

By Zacharias C. Zacharia, Marios Michael, Giorgos Olympiou, Vasoula Papasozomenou

Over the past few years several research studies have attempted to investigate and document the value of combining Physical Manipulatives (PM - real world physical/concrete material and apparatus) and Virtual Manipulatives (VM - virtual apparatus and material which exist in virtual environments, such as computer-based simulations) in science laboratory experimentation. However, up until recently a detailed framework depicting how PM and VM could be combined/blended was proposed in the literature of the domain (Olympiou & Zacharia, 2012). This framework takes into consideration the PM and VM affordances (qualities of PM or VM that offer the possibility of an interaction relative to the ability of a learner to interact) and specifically targets the content of each lab experiment separately. This framework has been tested successfully among undergraduate students. In particular, in these studies it was found that the use of a blended combination of PM and VM enhanced students' conceptual understanding in Physics more than the use of PM or VM alone. However, no data are available concerning the effectiveness of this framework in enhancing the conceptual understanding of younger students. In this study, we aimed at following the same research design as in previous studies, in which three conditions were used (PM alone, VM alone, and a blended combination of PM&VM), but implement them this time among primary school students. Our research question was to investigate whether the use of blended combinations of PM and VM, which are created according to the Olympiou and Zacharia, (2012) framework, enhance primary school students conceptual understanding of Electric Circuits more than the use of PM alone or VM alone do.

A pre-post comparison study design was used for the purposes of this study that involved 55 participants assigned to three conditions. The first condition consisted of 18 students that used PM, the second condition consisted of 18 students that used VM, and the third condition consisted of 19 students that used the blended combination of PM and VM. In the case of the blended combination, the use of VM or PM are combined according to the framework developed by Olympiou and Zacharia (2012). All conditions used the same inquiry-oriented curriculum materials and procedures. In terms of the experimental material used, PM involved the use of physical objects in a conventional physics laboratory. In the case of VM, the Virtual Labs Electricity software was used.

A conceptual test was administered to assess students' understanding before and after teaching. The data analysis involved both quantitative and qualitative methods. All tests were scored though the use of scoring rubrics and the resulted student performance scores were analyzed by using ANOVA, paired samples, and ANCOVA. The qualitative analysis involved the identification and classification of students' Scientifically Acceptable Conceptions (SACs) and Scientifically Non-Acceptable Conceptions (SNACs) concerning current in the context of circuits that included up to five bulbs connected in series or in parallel. The analysis involved all the items of the study's test and followed the procedures of open coding.

The findings of this study revealed that the use of a blended combination of PM&VM, according to the Olympiou and Zacharia (2012) framework, was more conducive to sixth graders conceptual understanding of the Electric Circuits concepts than the use of PM and VM alone. This complies with the findings of the studies that made use of the Olympiou and Zacharia (2012) framework at the university level for enhancing undergraduate students' conceptual understanding in Physics. Hence, it appears that the Olympiou and Zacharia (2012) framework could successfully be used at the primary school level, at least with students similar to our participants and in the domain of Electric Circuits.

Engineering students' teaching plans on periodicity: Transforming school texts

By Chrissavgi Triantafillou, Vasiliki Spiliotopoulou

This research is taken place in the context of a teachers' education course on Didactics, lasting one semester. The participants are mechanical engineers, who are going to teach in Technical and Vocational Secondary schools. During the semester they are introduced in teaching techniques, in designing interventions and in developing learning activities for their students. They also obtain experiences in analyzing school textbooks and handling text and images for the enhancement of their students' learning. Most of the course activities are organized around periodic behaviour. The future students have to take en exam at the end. Particular extracts from school engineering textbooks are given to the students before and during the final exam. The students are asked to study the texts; to look for appropriate information (from internet or other resources) in order to support their understanding of this topic; and finally to be prepared to teach it in class. Research goals concern the study of engineering students' experiences on the basis of two texts from the school textbook and of their efforts to transform the texts in learning activities integrating mathematical models of periodic functions.

The set of data consists of 86 engineering students' responses to tasks of the final exam in the context of the above course. Two tasks/topics have been given to students based on two school texts: "The bicycle Dynamo" (Task 1) and "Cars' suspension and tire springs" (Task 2). Both topics are real life applications of periodicity; are relevant to their undergraduate studies; and also relevant to students' interest as future mechanical engineers and as future teachers. Moreover the two extracts used include both text and visual representations. Students are asked to analyze the texts, explain particular graphical representations and then to design teaching activities on the particular topic by defining the teaching goal to be attained. Data from the second task are discussed in this study.

Inductive content analysis is applied on students' responses and a coding system of categories has been produced. The main dimensions discerned are the following: the type of text produced by the student-teachers; the role of school text in their descriptions; aspects of teaching in terms of scientific or educational approaches; the level of conceptual awareness; and the extend they employ aspects of periodicity in their teaching plan. Concerning the type of text, three types have been defined: the descriptive/narrative, the expository and the argumentative. Concerning the use of school text in their descriptions, this can be a mimic approach, or an interpretive approach or finally an enriching one. Focusing on the aspects of teaching and the scientific elements involved in the teaching design, these can be mathematical, general or particular like formulas and relations, physical laws and entities, and technological like batteries and car's suspension. Pedagogical aspects identified in their written answers refer to either experimental or theoretical approaches or to both. Three levels of conceptual awareness have been distinguished: the first level concerns descriptions that show that the student-teachers are trying to understand the conceptual field for themselves; the second level concerns descriptions, which appear to explain the concepts to their students; the third level concerns descriptions that consciously relate theoretical scientific knowledge to technological applications, or theory to graphical representations. Finally, the way suggested teaching activities are built on the periodic concepts can exist and be explicit or implicit involved or can be no reference to them.

Results show that a limited number of student-teachers (i) combine theoretical and applied aspects of knowledge, (ii) consciously use the knowledge in an argumentative way; (iii) develop integrated learning activities. Analysis of students' teaching design provides us with information about the nature of their knowledge and the importance of being able to relate theory and practice in teaching plans.

Impact of an Educational Video Game on Students' Conceptual Change Regarding Newtonian Mechanics

By Martin Riopel

According to McGonagall (2010), the average child in a country with a strong gamer culture will have spent 10,000 hours playing online games by the age of 21, which is about the same amount of time spent in school. This gaming time is so huge that one can certainly ask if video games have a role to play in education. This research studies the impact of Mecanika, an educational video game about the principles of Newtonian mechanics. A total sample of 185 high school students was selected for the current study. Experimental group (N = 94) received the treatment through Mecanika whereas the control group (N = 91) was selected to receive conventional instruction. Further, the students of control group played at Mecanika without any teacher assistance or instructions. The analysis of pretest and posttest scores of Force Concept Inventory (Hestenes et al., 1992) between both groups indicated that the experimental group's students significantly outperformed the control group. On average, students of experimental group obtained a higher normalized gain (M = .10, SD = .02) than students of control group (M = .02, SD = .02). An independent samples t test indicated that the difference was significant $t(183) = 3.81$, $p < .001$ and of medium size effect ($d = 0.6$). The results from this first part of the experimentation reveal that Mecanika may be an effective way to improve conceptual change for Newtonian mechanics. In the second part of the experimentation, students of control group played at Mecanika but, unlike other group, didn't benefit of any assistance. On average, students that have been playing at Mecanika by themselves obtained a comparable gain (M=.08, SD=.02) than

students who received the support of their teacher and of the guidebooks (M=.10, SD=.02) in part one of the experimentation. The results showed that difference was not significant and did represent a negligible effect. It seems that most of the game's potential to generate conceptual change comes with playing and not really with the integration in the verbal or written explanations in teacher's setting. Encouragingly, it can be proposed that this genre of learning games may prove suitable for engaging students by themselves in active exploration of core science concepts. The Mecanika game is available freely at http://Mecanika.ca.

Interest, Attitude and Motivation in Science and Technology Education Sessions

Saturday 31 May 18:00 – 19:00

Using contexts referring to human body to improve women's interest in introductory physics

By Geneviève Allaire-Duquette, Patrick Charland, Martin Riopel

The underrepresentation of women in university physics departments has been addressed by a large number of studies worldwide. Although in recent years the gender gap tends to close in many scientific fields, the gender disparity, both in the professional and academic sphere, does not resorb in physics. Among all sociological, psychological and cultural factors affecting the choice of women to pursue studies and careers in physics, there is a consensus that one of the most important factor is that women develop a significantly lower interest towards physics than men. Indeed, physics classes often involve problems that refer to technical issues or that are presented in a purely abstract context. This tendency could partly explain gender disparities and women's poor interest towards physics. It has been recognized that contexts concerning human biology, medical applications or natural phenomena are perceived of great relevance for girls and since they are virtually absent of physics curricula, it could be more difficult for girls to develop and maintain their interest for physics.

Interest is a motivational variable that refers to a psychological state of engagement or predisposition to re-engage in a certain type of tasks, events or ideas. The affective components of interest include the expression of positive emotions and are neurobiologically based. Although each individual has the potential to develop its interest, the object and the environment largely define the direction of the interest and the scope of its development. At the very root of the development of interest is the first phase, triggered situational interest, that involves a sudden change in the affective process. Situational interest for the study of physics can be triggered by classroom climate, teaching strategies, type of learning activities or the contexts in which physics content is presented. The learning environment, in fact, has the potential to generate situational interest even for students who have, a priori, a poor individual interest for physics.

To date, research in physics education addressing student's interest mainly employed subjective or contextual data, mostly questionnaires containing statements related to different scientific topics. Currently, no research has looked at the possible impact of the context of a problem on women's emotion while performing the task. Thus, no findings clearly demonstrate that the contextualization of physics has the potential to generate the sudden change in the affective processes that could indicate a triggering of interest. Psychophysiological data like electrodermal activity allow this type of recording in a

non-intrusive way, allowing a more direct and objective observation of interest that probes student's arousal while they solve physics problems.

The present research aims at comparing, from a psychophysiological approach, the interest generated by a context recognized to trigger girl's interest, the human body, and a context known to be mainly perceived as irrelevant for girls, the technical issues. Results collected from 13 women from college and university show that contexts play a significant role in triggering the interest of women for physics. Emotional engagement was significantly greater and more positive when women were solving problems referring to human body compared to technical issues.

Teachers' and Learners' Perceptions of the Mathematics, Science and Technology Curricula in Austria and Cyprus

By Veronika Rechberger, Michalis Livitziis, Judith Aldrian, Maria Hadjidemetri, Constantinos P. Constantinou, Leopold Mathelitsch

Curricula as significant policy statements function as guidelines for the creation of teaching-learning resources, setting the approach and emphases of assessment and framing the efforts and practices of teachers. Curricula in European countries vary between very brief to very analytical ones and between a focal point on didactic methods and approaches to a strong content focus. Whereas Austrian curriculum documents have a descriptive character and lay emphasis on the process of learning, Cypriot curriculum documents are more specific and content oriented. Embedded in education systems, also diversions on aspects in Austria and Cyprus are being taken into account in an effort to identify the routes of differences and similarities on the perceptions of teachers and learners between the two countries.

The main purpose of our study was to examine, through a mixed methods approach, the existing MST curricula as interpreted by their users, mainly teachers, and as experienced by the students. The research targeted learning at the ages of 5, 8, 11 and 13 years of age, as representative of preprimary, primary and lower secondary education. For this purpose, data was collected from teachers and learners through interviews and questionnaires. In our analysis we centre on the perspectives and rationales of teachers and students on MST learning and their perceptions of aims and objectives of MST curricula. Their notions on how the curriculum is applied in the school context through learning activities and the way they understand their roles when engaging with these activities are also explored with a special focus on the facet of motivation and interest. Environmental aspects, like materials and resources students and teachers have access to, along with the support structures of the educational systems that is provided, have an influence on the learning reality.

Variations between the two educational systems regard the age of entering lower secondary school which is at 10 years old in Austria and 12 years old in Cyprus. Teacher training for kindergarten is on the level of secondary education in Austria, whereas it is established on tertiary in Cyprus. Further differences of the two countries occur in teacher training on tertiary level for teachers for lower secondary schools.

Teachers' view on how visible and comprehendible aims and objectives are in curriculum documents is described. In both countries, most of the teachers think that the level of the curriculum is suitable for the students. However, in Austria more science and technology teachers disagree on the curriculum giving a clear view while more

mathematics teachers do in Cyprus. What kinds of activities teachers consider as motivating and which ones students like are also examined. Moreover, class compositions that would make it easier for them to apply the suggested methods is discussed. In both countries, the need for more professional development in order to teach in an adequate way is seen by teachers. In this context their suggestions for more effective seminars are presented. An influencing factor for learners' attitude in both countries towards subjects is the sympathy for the teacher, related to good explanation and teachers' attitude towards learners. Furthermore, it is discussed what Cypriot and Austrian teachers consider important for successful teaching, along with materials and resources they use or they would like to use in order to achieve that.

Differences in systems and curricula seem to effect teachers' and learners' perceptions and practice even though more similarities can be found in relation to the implementation in class.

A Review on Girls and their Interest for Science and Technology: Which Questions does Research ask and how does it Answer them?

By Marie-Hélène Bruyère, Patrice Potvin, Abdelkrim Hasni

Every year, a relatively small number of teenagers choose to pursue a career in a scientific or technological domain. Moreover, decades after gaining access to these traditionally male professions, women are still fewer than boys in choosing a scientific career path; those who do being mostly concentrated in fields related to care. Thus, women account for less than a fourth of computing and engineering students in OECD countries. This situation has raised many questions related to the ways schools can help students, especially girls, develop and maintain an interest in science. Research has tried to answer some of them in many ways, looking at factors explaining differences of interest among students, or by suggesting effective interventions to stimulate interest. Results on girls' interest in science have also been reported in reviews.

In this presentation, we will focus on how this knowledge is acquired. By examining the questions that recent research projects asked and the methodology they used, we wish to provide a picture of the current trends in research on interest, and identify different angles from which it is possible to tackle the issue.

For the purpose of this review, the ERIC database has been queried for journal articles published since the year 2000 and which title contained the keywords interest or attitude, and science, as well as gender, sex, or girls in their abstract. Of those articles, only empirical researches which sample included kindergarten, elementary or high school girls were kept. With these criteria, a corpus of 55 texts was assembled. Each of them was read twice, and information on the research questions and the methodology used were coded in an analytic grid. Specifically, we focused on the dimensions of science and technology targeted, as well as the studied variables, the importance allocated to gender, and how data was collected and analyzed. Groupings of similar elements were then established.

Preliminary results indicate that most studies looked at older elementary aged children and teenagers, and tried to assess their interest for science and technology in general or to pursue a science career. Researches on the effects of different pedagogical or out-of-school interventions were also an important part of the corpus. Mostly, the results were produced using quantitative analysis and questionnaires. When gender was central to

the research question, it was either to study girls themselves or to establish comparisons between boys and girls. However, the majority of the articles used gender as a variable to add precision to the data analysis. The entire set of results will be available at the conference. Conclusions and suggestions for future research will also be included.

Effects of hands-on activities and inquiry-based science learning on interest, motivation and attitude toward science and technology: a review

By Vincent Belletête, Abdelkrim Hasni, Patrice Potvin

The aim of this presentation is to offer an overview of recent educational research about the effects of classroom interventions on interest, motivation or attitude (I/M/A) toward science and technology (S&T). This synthesis has been conducted as a part of a larger review that implicated a systematic description of 228 research articles about I/M/A towards S&T that has been carried out by the Chaire de recherche sur l'intérêt des élèves à l'égard des sciences et de la technologie (CRIJEST). Selected articles were indexed in the ERIC database and published between 2000 and 2012. They were analysed with a grid composed of 36 multi-choice and open-ended items about the general information of each article and of its content : 1) type and scope, 2) evoked and defined I/M/A theoretical constructs, 3) description of the intervention that aimed at developing I/M/A, 4) research methods (variables, tools used, sample, etc.), 4) results. Among all the interventions that had been studied in the selected articles, five categories were considered: 1) hands-on activities, 2) inquiry-based learning, 3) use of information and communication technologies (ICT), 4) collaborative work, 5) contextualization. Although many of the articles reported comparative results (before/after, with/without intervention), few of them merely reported results obtained with only one questionnaire or survey that contained questions that referred to improvements of I/M/A. Most of the interventions had positive effects on students' I/M/A. For example, inquiry-based learning tended to favour I/M/A not only because students could manipulate objects or instruments, but because of their cognitive involvement in the tasks they performed. It also appeared that a good contextualization of content knowledge to be taught (for example, linking content with real-world issues, real phenomena or current events) appeared to be important in order to get students interested. Based on this synthesis' findings, conclusions and recommendations for future research about classroom interventions and their effects on I/M/A will be formulated.

The effect of Technological Design Processes (TDP)-based activities on Students' Interest in Science and Technology Classes

By Nancy Brouillette, Patrice Potvin, Ghislain Samson

Studies from across the world indicate that students have little interest in scientific and technological careers. Furthermore, despite efforts to attract more girls to science and technology (S&T), very few of them pursue a career in the field of engineering. This evidence has motivated researchers to further examine the interest levels of students towards S&T, both at the primary and secondary school levels. Among practices that are

known to favour the development of students' interest for S&T, the Technological Design Process (TDP) has been identified as promising not only because it happens in a problem-solving context, but also because it implies hands-on activities.

This presentation summarizes a doctoral research project assessing the effect of TDP on student interest in S&T. This study uses actual students from primary and secondary schools in Canada (within the province of Quebec). A Pre/post-test design, using control and experimental groups (both for the same teacher), will be applied. In the experimental groups, students will carry out tasks requiring TDP. Teachers of the participating classes will have received training to ensure that the developed activities are consistent with TDP. They will also be accompanied by a pedagogical councillor in order to ensure conformity.

The presentation is organized as follows: first, an overview of the literature on the interest of girls and boys in S&T will be given. Then, the constructs of the study—the interest indicator and the TDP—will be defined. Afterward, the experimental protocol and the data collection tool will be presented. One of the tasks performed by the students will briefly be described to illustrate an example. Special attention will be devoted to the data collection tool, which is a variant of the General Questionnaire of the Chaire de recherche sur l'intérêt des jeunes à l'égard des sciences et de la technologie (CRIJEST). Finally, an analysis of preliminary data will be presented.

Interest and disinterest from college students for higher education in Sciences

By Michel Pronovost, Caroline Cormier, Patrice Potvin, Martin Riopel

Although Science occupy an important place in the society, we observe worldwide a lack of interest from the young people for scientific studies. Indeed the proportion of science students in universities has been continuously decreasing for the last 15 years and an increasing gap is observed between the social demand and the scientific expertise. There are several reasons which influence the young people in their choice of College program. Beyond the considerations of personality and beyond the taste, factors related with interest for Science can influence positively or negatively their inscription in a Science college program. To bring to light the most striking factors, we questioned 3000 students of various pre-university programs to sound their interest and their motivation for the sciences and to try to understand what had urged them to join Sciences or not in College. We will present emotional, behavioral and cognitive factors associated to the interest or to the disinterest of students for higher education in sciences. We will consider the influence of the professors, the peers and the family, the feeling of skillness, self-determination and the prejudices which students maintain for Science.

Workshops

SiS Catalyst Workshop: "Children as Societal Actors for a Sustainable Future"

Presenter: Mr. Florian Kaiser, Policy Assistant, International Centre for Excellence in Educational Opportunities, The University of Liverpool

Short description: "SiS Catalyst - children as change agents for science in society" is a four year FP7 Mobilisation and Mutual Learning (MML) project. SiS Catalyst is exploring the interrelationships between science communication practices and social inclusion while focussing on the perspectives of children. The workshop will explore the outcomes of the SiS Catalyst Project and how these outcomes can be transferred to other contexts. The activities will be based on the concepts of locally defined minorities and inclusive excellence as drivers for social inclusion, and as well the seven core recommendations of the project (http://www.siscatalyst.eu/resources/strategic-paper).

Creat-IT Workshop: Introducing "Creative Science"

At first glance 'science' and 'creativity' may seem to be two completely different ideas. But there is, perhaps, a common ground for national educational curricula to build inquiry-based science education activities based upon interdisciplinarity and interaction involving creativity from the Arts.
-Can science-education become a starting point towards a holistic approach for "humanizing creativity"?
-Can we invite students to ask questions about science through performing drama, music or poetry?
CREAT-IT project seeks to provide teachers with the ability to blend innovation approaches with traditional science teaching methods.
CREAT-IT aims to develop and support late primary and early secondary teachers' skills in science education by integrating in science other creative and cultural disciplines (from music & theater) & social media tools in formal education systems.
CREAT-IT is combining Science, Culture, Creativity & Technology.

16:00 – 17:00	**What has already been done in the field?** Presentation of the Creat-IT consortium, A brief summary of what has been accomplished before the Creat-IT project.
17:00 – 18:00	**What do we expect for the future?** The 3 case studies and the envisaged plan. Discussion with the teachers about scenarios with their classes. Participants write down their scenarios using Creat-IT template.

Greece	Greece	UK	Italy	Norway	Belgium	Serbia
Ellinogermaniki Agogi (Research & Development Department) - EA	Hellenic Association of Science Journalists, Science Writers and Science Communicators - Science View	University of Exeter, EXETER	Forma Scienza	Stord/Haugesund University College - HSH	European Network for Opera and Dance Education - RESEO	CENTER FOR THE PROMOTION OF SCIENCE - CPN

Poster Presentations

New perspective in science education research: education in refugee camps

By Olivier Arvisais, Patrick Charland

Over the past decade, many efforts have been made to provide access to education following the rise of the global movement Education for All (EFA). However, the last EFA Global Monitoring Report suggests that governments around the world are about to fail to meet their collective commitment. In view of this and as the 2015 deadline for achieving the EFA goals approaches, it is essential to address the last remaining barriers that still impede access to education.

There are indications that armed conflict is one of these persistent barriers. Indeed, half of the 57 million children not in school live in countries either affected by conflict or that are emerging from conflict. To address this issue, education was recognized as an emergency sector in its own right, as part of the United Nations (UN) Humanitarian Reform process in 2007. This result in bringing education to camps under United Nations High Commissioner for Refugees (UNHCR) authority. Prior to this reform, education was sometimes, but not systematically, present in the camps.

Despite these recent changes, researchers have long emphasized the lack of information on how education initiatives in the camps meet children's needs. United Nations Educational, Scientific and Cultural Organization (UNESCO) also reports that refugee education data are scarce. Furthermore, UNHCR recommended, in 2012, that analyses be conducted taking into account educational policies, pedagogical infrastructures and curriculum.

New developments in science education are numerous, but it is important to remember that many children in the world do not have access to scientific education. In case, due to the context of emergency education where teachers have to deal with a lack of material and infrastructure, the scientific contents are too often removed from the effective curriculum in refugee camps.

It is important to bear in mind that the line between science education and other needs of refugees is often very permeable. Among the available information, this poster presentation aims to provide an overview of the intended curriculum used for primary and secondary school science education provided in camps. It will raise questions and discuss stakes about the relationship between science education and children's educational and basic psychosocial needs, as well as the basic needs of refugee communities. It must be mentioned that this presentation is part of a larger research project, which will aim to describe the relationship between refugee's educational needs and camp global intended curriculum.

Outdoor science education to favour student's interest in science

By Jean-Philippe Ayotte-Beaudet, Patrice Potvin

One of the most important questions in science education is how to generate interest because its presence or absence is strongly linked to knowledge acquisition and drop-out. In recent years, many research initiatives found that hands-on activities are among the ones that favour interest in science the most. Moreover, when practiced in authentic environments, they appear to have an even greater potential to do so. Therefore, in formal or informal contexts, outdoor science education, since it implies hands-on experience and authenticity, might also positively influence students' interest and learning. To favour students' interest in science, teachers should consider outdoor activities. Nevertheless, science education doesn't often take place in authentic environments; instead, it usually occurs in artificial environments, such as classrooms and laboratories. Thus little importance is usually given to outdoor science education in the everyday context. The few available studies about the effectiveness of outdoor science education to favour interest in science unfortunately occur primarily in informal educational contexts, like science camps or field trips. Those activities require extraordinary resources and more time than ordinary courses. Thus research rarely studies outdoor science education in regular course circumstances. More research efforts are therefore needed to better understand outdoor science education in regular teaching contexts.

In this research we ask two questions: (1) To what extent does outdoor science education, experienced in the immediate vicinity of secondary schools, favour student interest? (2) What pedagogical and organizational choices about outdoor education will optimally favour student interest in science?

About fifteen secondary science teachers will participate in this research. Each of them will teach to two groups. One of them will stay indoors for the duration of the study and the second group will go outdoors five to ten times during regular teaching periods. Outdoor science activities will be planned by the teachers with the help of our research team to respect factors known to facilitate outdoor education in non-formal scientific contexts. Mixed methods will be used to collect data. Qualitative data will come from 1) passive observation, 2) two individual interviews with teachers and 3) a group interview. Quantitative data will be collected from 900 students using a Likert scale questionnaire distributed before intervention, at the end of the process and six months later. The data collection is anticipated for 2014-2015. Our poster reports about context, theoretical framework and methodology of our study.

Proposing a Research Design to Explore the Neural Correlates Underlying Conceptual Understanding of Counterintuitive Concepts in Science

By Geneviève Allaire-Duquette, Michel Bélanger, Roland H. Grabner, Steve Masson

Learning science can be challenging for high school students. Research inscience education has shown that these difficulties are, at least in part, due to the fact that students often have misconceptions that are difficult to change about how nature works. However, the reasons why some students, who benefited from a comparable scientific training, have more difficulty than others to overcome their misconceptions remain

poorly understood.

Based on recent studies showing that experts in science activate (more than novices) brain areas related to inhibition in order to suppress their misconceptions, we hypothesize that students having difficulties to learn scientific concepts might show less activation in brain areas related to inhibition compared to students who perform well.

To test this hypothesis, a research design is currently being developed. It involves 40 high school students (20 having conceptual difficulties and 20 performing well) responding to questions related to physics and biology concepts in an fMRI scanner. Student's performance will be measured using validated conceptual tests (e.g. Hestenes, Wells, & Swackhamer, 1992). Participants in both groups will have received similar scientific training and will be paired based on age, socio-economic status and reading abilities. The task will involve evaluating the correctness of counterintuitive and intuitive statements or situations related to natural phenomena that are either true or false. It is expected that students having conceptual difficulties will show less activity in brain areas involved in inhibition (such as ventrolateral prefrontal cortex, dorsolateral prefrontal cortex and anterior cingulate cortex) for the contrast counterintuitive > intuitive.

Learning physics through videogames: a neuroeducation angle on motivation and learning.

By Skelling-Desmeules, Y., Charland, P.

It is predicted that scientific careers will become more and more in demand in our society. To address this issue, it has been suggested to redefine the teaching programs to make them more engaging, especially by putting emphasis on interactivity instead of the frequently employed lectures.

Some researchers argue that video games might be a good way to bring interactivity to the classroom, thus raise interest for learning contents. Known to be very popular amongst teenagers, they allow students to take an active part in their learning. Serious games in physics are also built around central scientific concepts, allowing the emergence of an intuitive comprehension, which in turn leads to a better abstract comprehension of the scientific concepts.

Despite these arguments, other researchers doubt about the usefulness of video games as a learning tool. Most of these critiques are about the lack of studies on video games, and the flaws in the existing ones. On the one part, many studies involving video games as a learning tool do not include a control group. Also, bringing a video game to a classroom for a study adds an element of novelty, which might affect the interest of the learners more than the game itself. The different measurement tools used to assess motivation could also give different results for the same groups, and the delay between the gaming period and the motivation assessment could bring a bias to the results. Finally, the science content between gaming groups and control ones tend to differ considerably.

The present research aims to further advance knowledge on video game learning by addressing these issues. Thirty-six (36) undergraduate participants were assigned to one of the two following conditions: the gaming condition, in which the participants had to play Mecanika, a serious game involving Newtonian physics concepts, or the non-

gaming condition, in which they had to watch small clips of a teacher playing Mecanika while explaining his thought process. Learning was measured by administering the Force Concept Inventory before and after the learning period. As for motivation, recent research in neurosciences found correlates to task engagement by using electroencephalographic (EEG) and electrodermal activities (EDA). Both of these tools were used to measure engagement in every subject, in combination with a motivation questionnaire administered at different times throughout the learning session.

The projected analysis will involve the comparison of the two experimental groups on learning and engagement. It is hypothesised that the gaming group will show more engagement in the learning task than the non-gaming group. The second hypothesis is that the gaming group will show better learning than the control condition. The final hypothesis is that the inferred engagement measured via EEG and EDA will correlate better with learning than the self-report questionnaires.

Differences in Brain Activation Between Novices and Experts in Science During a Task Involving a Common Misconception in Mechanics

By Lorie-Marlène Brault Foisy, Patrice Potvin, Martin Riopel, Steve Masson

An extensive research literature in the field of science education reveals that students often hold misconceptions about various phenomena. These misconceptions, generally opposed to scientific knowledge taught in school, interfere with learning and therefore complicate the emergence of a true understanding. These misconceptions are known to be highly resistant and hard to change because they require achievement of a conceptual change. However, despite the many theoretical models of conceptual change available, there is no consensus on the processes underlying conceptual change, and also, there is no consensual answer as to what happens to the initial conceptions of students after the completion of a conceptual change. Are these initial conceptions deleted, reorganized, replaced, integrated into a new, broader theory or do they remain present, therefore coexisting with new scientific knowledge?

Recent studies, particularly in the field of electricity, point to the idea that the brain's mechanism of inhibition would play a role in learning science. According to this idea, students' conceptions would not necessarily disappear following a conceptual change: students would have to learn to inhibit them to provide a scientifically correct answer. Since mechanics is a scientific discipline in which the initial misconceptions of learners are among the best known and the most frequent and persistent, it is of great interest to verify whether inhibition plays a role in learning concepts specific to this discipline. The main objective of this research is to determine whether experts in mechanics still hold misconceptions in their brain, which they have to inhibit in order to answer scientifically. The main hypothesis is that the experts will present stronger cerebral activations than novices in brain regions associated with inhibition (i.e. ventrolateral and dorsolateral prefrontal cortex) when they have to answer questions involving the common mechanical conception « a heavier ball falls faster than a lighter ball ».

To test this hypothesis, two groups of participants were compared: a group of novices (n = 19) who show misconceptions in mechanics and a group of experts (n = 10) who are presumed to have already undergone a conceptual change (because they do not show certain misconceptions in mechanics). Using functional magnetic resonance imaging

(fMRI), images of the participants' brain activity were taken while resolving a cognitive task in mechanics. The task consisted of the presentation of films in which two balls of different sizes were falling at identical or different speeds.

The results show that experts activate, significantly more than novices, the areas associated with inhibition (dorsolateral and ventrolateral prefrontal cortex). This suggests that their preconceptions in mechanics have not been eradicated or transformed during learning: they would rather persist, and subjects would therefore have learned to inhibit them to provide scientifically correct answers. This research contributes to a better understanding about the role of inhibition in learning sciences. The results show that there is a difference in brain activations between subjects who perform better in mechanics (experts) and the ones who fall more easily in misconceptual traps (novices). According to this analysis, expertise in mechanics would therefore be linked to a better ability to inhibit one's spontaneous misconceptions. For this particular context, it would appear that students would benefit more from learning to inhibit their misconceptions rather than strive to delete, or restructure them into a new theory.

The role of inhibition in physics-related conceptual change

By François Thibault, Patrice Potvin

Experienced Science Educators and teachers all have taught topics that appear to be systematically more difficult for students to learn. Many of these difficulties have been studied extensively over the years, and are now generally attributed to the existence of prior conceptions which interfere with students' learning processes and reduce the effectiveness of traditional teaching methods. Recent research in the field of neuroeducation, using functional magnetic resonance imaging (fMRI) to study the process of conceptual change, suggest that these prior conceptions never completely disappear or change, but rather need to be inhibited for more scientifically accurate conceptions to manifest.

This research thus aimed at quantifying the effect of students' inhibition capacity on their ability to perform conceptual changes in science. At the beginning and the end of a semester, during which the subjects undertook an undergraduate introductory course in Newtonian Physics and Classical Mechanics, tests were performed to assess the subjects' level of expertise in physics (Force Concept Inventory [FCI]) as well as their inhibition capacity (Wisconsin Card Sorting Test [WCST]).

Statistical analysis showed that 18.2% ($\rho < 0.005$) of the variance observed in students' conceptual change (represented by their improvement on the FCI over the course of the semester) can be explained by their inhibition capacity as measured by the WCST. Furthermore, students showing a higher inhibition capacity had a 61.4% chance of also achieving better conceptual change results when compared to their fellow students.

These results suggest that improving one's inhibition capacity might facilitate the learning of science in fields where traditional methods have shown reduced effectiveness because of the omnipresence of preconceptions. Further research will focus on teaching interventions and methods susceptible of developing students' inhibition capacity, hopefully allowing science educators and teachers to make students progressively better at learning science.

Integration of sexuality education by science and technology highschool teachers: analysis of their practices and conceptions

By Guillaume Cyr, Patrice Potvin, Joanne Otis

Different social current issues such as hypersexualisation, homophobia and transphobia have brought researchers to reaffirm the necessity of addressing them in the school curriculum. Though, since the Quebec's recent educational Reform, sexuality education is no more the responsibility of a specific teacher (Personnal and social training curriculum), but it should be provided by the interdisciplinary collaboration of different teachers. This situation leaves the science and technology teacher as the only one with the obligation to teach sexuality-related concepts: STIs, contraception, anatomy of the reproductive system, puberty, etc. Considering these recent changes in the Quebec's school curriculum, this research aims to understand how science and technology high school teachers integrate sexuality education.

Research conducted on this theme has analysed teachers' conceptions about sexuality and sexuality education. Their results show that biology teachers have more deterministic conceptions than their elementary and language collegues. As teachers' conceptions are known to limit their student's learning, this research will focus on them from perspective of Clément's KVP model. This model describes conceptions as the results of the interactions between scientific knowledge (K), values (V) and social practices (P) of an individual.. The analysis will be based on adaptations of typologies from researches in sexology, education and feminist studies.

This multiple case study will use a qualitative methodology. The sample will be composed of six science and technology high school teachers who will be identified by educational advisers as teachers who integrate sexuality education within their classes. First, observations of a sexuality education teaching sequence will allow us to prepare the interview protocol. Second, during interviews, it will be possible to clarify teachers' conceptions and identify motives that are invoked to justify the choices of practices observed.

Proposing a Research Perspective on What Happens to Misconceptions After a Conceptual Change

By Marilyne Larose, Martin Riopel, Patrice Potvin, Steve Masson

An extensive research literature in the field of science education reveals that students often hold misconceptions about various phenomena. These misconceptions, generally opposed to the scientific knowledge taught in school, interfere with the acquisition of new scientific concepts and resist even after explicit teaching of scientific concepts. Despite the many theoretical models of conceptual change proposed so far, the processes that underlie conceptual change and, more specifically, what happens to misconceptions after a conceptual change remains poorly understood. It is possible to identify two main hypotheses emerging from research on conceptual change. The most cited in the research literature is the one arguing that misconceptions are deleted, replaced or radically restructured after a conceptual change. The second, less cited, argues that the misconceptions are still present after a conceptual change, therefore coexisting with the learned scientific conceptions. According to this hypothesis, learning science would develop the ability to inhibit its misconceptions, i.e. the ability to control

or block them, to provide a scientifically correct answer.

Although recent studies seems to indicate that undergraduate students in physics need to inhibit their misconceptions to provide a scientifically correct answer, we don't know if inhibition is required even after a more extensive scientific training. Indeed, it is possible that the inhibition plays a long, important, but temporary role in science learning. In order to verify whether the role of inhibition in the scientific expertise is temporary or permanent, it is necessary to conduct a similar experience to those previously made, but, this time, with professional scientists who have completed doctoral studies in physics. Based on recent studies discussed above, we hypothesize that professional scientist might show more activation in brain areas related to inhibition when they analyze phenomena involving misconceptions.

To test this hypothesis, a research design is currently being developed. It involves 24 professional physicists responding to questions related to physics and biology (control domain of knowledge for which subjects have no particular expertise) concepts in an fMRI scanner. The task consists of evaluating as quickly as possible the truth-value of counterintuitive and intuitive statements related to natural phenomena. While the truth-value of counterintuitive statements changes across conceptual change, the truth-value of intuitive statements remains constant. It is expected that professional scientists will show more activity in brain areas related to inhibition (such as ventrolateral prefrontal cortex, dorsolateral prefrontal cortex and anterior cingulate cortex) for the contrast counterintuitive > intuitive.

The Effects of Polarization in the Teaching of Science and Technology in Specialized Schools on Student Achievement: The Case of the BST

By Ousmane Sy, Patrice Potvin

In Senegal, the question of teaching science has been given serious thought over the past two decades. In a developing country like Senegal, science and technology are extremely important to the country's socio-economic development strategy. The situation has been analyzed and understood by the Senegalese education authorities who, since the 1980s and with the support of the World Bank and UNESCO, have proceeded to create a new type of institution that is responsible for teaching science and technology at the middle school level (Moyen), called scientific and technological blocks (Bloc Scientifique et Technologique [BST]). Using an experimental approach and an adapted scientific approach, these institutions enhance the teaching and learning conditions for science and technology and aim to ensure the success of high-school students (secondaire). For economic and efficacy reasons, BSTs follow an original blueprint that favours innovative principles in the organization of teaching and learning science and technology. In fact, students come from different middle schools (collèges d'enseignement moyen [CEM]) in the BST area. Each BST has specialized rooms (at least two per discipline so that classes can be split in half). The rooms have been especially designed for teaching small groups (groups of 24 students divided into six sub-groups), allowing students to take part in activities that will help them learn the scientific approach and perform experiments. In this paper, we will conduct a comparative analysis of the passing rate on the national exams (BFEM) among students who attend BSTs and those who do not have the opportunity to study science at a BST in order to measure the usefulness of the BST formula on the academic achievement of science and technology students.

Implementing an interdisciplinary approach in elementary classes by using science and technology as context for learning other disciplines

By Claude-Émilie Marec, Patrice Potvin, Abdelkrim Hasni

Numerous studies state a disengagement of elementary school teachers towards the fields of science and technology (S&T), depriving the students from scientific culture and of adequate preparation to subsequent S&T courses. These studies reveal a low sense of teachers's self-efficacy resulting essentially from a deficient training rather than a lack of will. In the Quebec Province, in the 90s, the Ministry of Education required the school authorities to ensure that S&T should be taught according to the prescribed program and that it will be within an interdisciplinary approach. However, researches show that the problem remains even today : the teaching of S&T is too often put aside for the benefit of basic subjects such as french and math. Interdisciplinary approaches are also very neglected by teachers, although they are strongly encouraged by the state program.

Within the framework of CRIJEST (Chair on the interest of youngsters towards S&T), the objectives of this research are to promote and enhance S&T teaching in an interdisciplinary approach among elementary school teachers and to reinforce attraction of students for S&T and their related professions. Based on studies demonstrating the relevance and the necessity of a continuous training so that a change of educational posture can take place, this research proposes to work in a participative and collaborative process with voluntary teachers of grades 5 and 6 of an elementary school, for a duration of 4 months. To bring a pragmatic solution to the problematic, the used methodology is an action-research that involves weekly meetings between participants and the researcher. Its purpose is to engage teachers in an interdisciplinary approach that brings S&T at the heart of their teaching, the first phase of this approach being a reorganization of the disciplines'curricular contents to establish bridges between them. Means to introduce S&T in an interdisciplinary approach are planned and such activities are prepared so that they can be, and eventually are, applied by the participants in their classes.

This research attempts to bring elements of responses to the following questions : (Q1) : does an interdisciplinary approach favour a more steady interest of the teachers for teaching S&T ? (Q2) : does participative and intensive approach (4 months period) allow the actions of the teachers committed in their new educational practice to be sustained ? and (Q3) : does such an implementation generate a greater interest of the students towards S&T ? For Q3, a questionnaire developed by the CRIJEST will be submitted to the students of the participating teachers before and after the implementation. For Q1 and Q2, interviews will be used. Preliminary data will be communicated at the conference.

Scaffolding a computer supported inquiry learning process: the interplay between implicit and explicit guidance

By Maria Margoudi, Ioannis Kostikas, Zacharoula Smyrnaiou

Recent research has proven that scaffolding practices which were used in the past can no longer be successfully implemented in the classroom because of complexity issues. Although researchers agree on the use of technology, in the form of computer- based scaffolds, they have not reached an agreement on the types and aims of scaffolding features used within the educational design community. This gap has been filled by a proposition of a common framework of scaffolding types including: scaffolding in the field of domain knowledge, inquiry pathway, sequencing, feedback, and cueing.

The issue of explicit versus implicit instructional guidance constitutes another important issue which has been studied by researchers in education technology, with regard to the goal of supporting both content and process goals. Explicit scaffolding can be provided by a physical activity, a worksheet or a teacher/novice researcher, whereas, implicit scaffolding can be deduced from the exploited technological tool by the merged perspectives of pedagogical scaffolding and the intuitive interface design.

Within the cognitive field of STEM sciences and practices the presence of expert scaffolding, as well as, epistemological guidance is considered necessary. An innovative approach to science education which incorporates the use of computer- based learning environments with virtual scaffolding possibilities is the Inquiry- Based Science Learning (IBSL). The E- Slate platform which is exploited in the current study constitutes such a computer- based environment. This environment composes a source of pre-manufactured educational software, as well as an authoring system and a system of secondary software development. In the design of E- Slate microworlds implicit- rather than explicit- scaffolding is utilized, and they set examples of inquiry learning environments through the exploration of which users learn about a variety of topics, such as science, mathematics, and history.

The present study is based on the findings of a previously conducted research which revolves around the design and construction of an E- Slate inquiry- based microworld which negotiates the scientific concepts of Kinematics and Dynamics in Physics education. Our study is focused on an effort to trace both explicit and implicit scaffolding techniques utilized while students were experimenting with this scientific microworld, engaged in an inquiry- based activity. In order for this goal to be achieved, we focus on two basic research questions:

1) What are the role and significance each of the five scaffolding types during an inquiry learning process that integrates the engagement with an e-slate scientific microworld?

2) What is the interaction between implicit and explicit scaffolding techniques in an Inquiry-Based Science Learning (IBSL) activity for science education?

An on- going case- study which follows the design- based research framework is being conducted in order to address our research questions. According to the design which has been planned, the research will be carried out in school setting with a small group of students being employed. The students are expected to engage in inquiry-based science learning (IBSL) activities with the application of both implicit and explicit instructional guidance. In order to fulfill this purpose, the research tools employed are an E- Slate inquiry- based microworld which negotiates the scientific concepts of Kinematics and

Dynamics in Physics education, appropriately structured spreadsheets used to facilitate the inquiry process and an assessment questionnaire for the completion of the intervention.

As mentioned before, the present research is ongoing and its results are expected to be drawn by the end of the month.

Art, Design and Journalism approach in science teaching (ADJ[A]ST) as an Innovative way to make science education attractive to girls

By Evangelia Petropoulou, Eleni Spinou, Zacharoula Smyrnaiou

During the last decade, Europe has turned its attention to attracting more girls in science education and consequently in scientific careers. However, despite targeted strategies and policies that have been established for this purpose women are still fewer than boys in choosing a scientific career path whereas they seem to be attracted to Education and Training studies as well as Humanities and Art studies. A basic reason for this gender disparity and women's poor interest towards science is the fact that science classes often involve problems that refer to technical issues –mostly endorsed by men- or that are presented in a purely abstract context. On the other hand, issues of proven interest for girls are virtually absent of science curricula depriving them from the motivational variable and creative engagement which are crucial in the learning process. In addition, science curricula seem to disregard contemporary pedagogical approaches in science teaching that can stimulate girls' emotions and motivation. This situation has raised many questions related to the ways educational policies and teaching practices can help girls develop and maintain an interest in science.

In this presentation we analyse the objectives of the ADJ[A]ST project, at its initial stage though, which involves an attempt to shed light to the appropriate contexts and pedagogical practices that must surround science teaching in order to trigger girls' motivation and interest as well as their emotional engagement. The innovative idea of this project lies on its systemic three-stage research approach. During the first stage there will be a thorough research on the biological and environmental criteria as well as the socially constructed parameters that prevent girls from demonstrating interest in science. This stage which involves the collaboration of the epistemologies of anthropology, sociology and psychology will enable us to draw conclusions on the contexts that need to support science teaching in order to raise girls' motivational rate. The second stage involves the practical use and application of the findings of the previous stage in order to design effective teaching interventions with a main focus on stimulating girls' interest in science lessons. The teaching interventions will be formed on the basis of creativity and will include three different approaches: a) contextualisation of science through an artistic approach (opera, music, drama), b) reinforcement of pupils' role as designers of digital tools in order to engage girls in hands-on experiences and c) diffusion of scientific knowledge with pupils assuming the role of a journalist. Through the interdisciplinary view of science and the application of approaches that promote creativity it is intended to raise girls' interest towards science studies and create a new perception of science with implications extending to all aspects of life. These approaches not only will add to the triggering of students' interest but with students' cognitive involvement in the contextualized tasks they perform they will also cultivate their creative imagination which is a necessary skill for the development of

science. Finally, the last stage aims to examine and analyse the issue of emotions as triggered during girls' engagement in the creative activities of the previous stage. The measuring of the girls' emotional engagement with the use of tools informed by Affective Neuroscience and Neuroeducation will enable us to strengthen the argument of our study and draw conclusions on the efficacy of creativity-promoting approaches in raising girls' interest in science. The research results will enable us to form efficient educational interventions and 'adjust' the scientific contexts and approaches with the aim of triggering girls' interest in science courses.

Responsible Research and Innovation in Science Education: The IRRESISTIBLE Project

By Dimitris Stavrou, Jan Apotheker, Ron Blonder, Ilka Parchmann & Lorenz Kampschulte, Paul Hix, Sevil Akaygün, Pedro Reis, Michele Floriano, Margherita Venturi, Ilkka Ratinen, Antti Laherto, Iwona Magiejowska, Gabriel Ghorghiu, Christina Troumpetari

The partners in the IRRESISTIBLE-project develop activities designed to foster the involvement of high school and elementary students and the public in Responsible Research and Innovation. We raise awareness about RRI in two ways:

- Increasing content knowledge about research by bringing topics of cutting edge research into the program
- Fostering a discussion among the students about RRI issues about the topics that are introduced

The topics selected cover a wide range of cutting edge science and technology research issues as the following: Nanoscience and Nanotechnology, Climate Change, Healthy Ageing, Genomics and Oceanography.
The aim of the project is to combine formal (at school) and informal (at an exhibition, science centre or festival) teaching to familiarize schoolchildren with science. Sixteen partners in ten countries are involved in this European project coordinated by Science LinX.

All participants will establish a community of learners (CoL). These communities will comprise schoolteachers together with faculty, experts in the field of science communication and science centre staff.

In the project, ten CoL will develop materials that the teachers will use at their own schools. Students will develop an exhibit for a science centre in their own country. The exhibit should engage the audience in the relationship between research and society.
Once they have completed their teaching module, the teachers will each train five colleagues, in using the developed modules from the first year.

Ultimately, this project will teach almost ten thousand pupils to consider the social impact of scientific research. The participating academics will be able to learn from it as well.

Creativity as boundary-crossing integration processes between math and environmental education supported by the C-Book environment

By Chronis Kynigos, Maria Daskolia

Creativity is acknowledged as a transversal backbone skill, necessary to foster each of the eight lifelong competences identified by the European Commission as essential for personal fulfilment and development, social inclusion, active citizenship and employment. Mathematical competence is among these core competences, comprising the ability to develop and apply mathematical thinking to solve a range of problems in everyday situations and the application of this knowledge and methodology in response to perceived human wants or needs. The same applies to creativity with regards to understanding and coping effectively with current environmental issues and as a prerequisite for visioning and designing alternative sustainable futures. However, most educational systems and school curricula fall short from being able of promoting creativity in any of the two domains, let alone in conjunction with each other.

We argue that math education can acquire new creativity potentials if 'bridged' with educational domains which are more socially-oriented and centred to real-life problems, such is the case of Environmental Education (EE). Our argument draws on that problem-posing and problem-solving offer appropriate learning formats for creativity, provided the 'problematic situation' exemplifies a set of characteristics such as that it is fairly ill-structured and messy; can change with the addition of new information; is not resolved easily or with a specific formula; and doesn't result in one right answer. These characteristics are directly applicable to most environmental and sustainability issues. Our suggestion is therefore that learners have more opportunities for boosting their creativity if appropriately challenged to identify the 'mathematics' hidden inside some of the current socio-scientific and sustainability issues.

In this paper we focus on the creative boundary-crossing endeavours which were realised within a team of Greek math and EE teachers, all members of a Community of Interest (CoI). The teachers were assigned the challenge to design digital educational resources fostering the creative mathematical thinking in their students, by using current environmental and sustainability issues as general problem-generator themes. To further boost these social creativity processes it was deemed appropriate that the CoI's work is positioned within a new genre of technological environment, an authorable e-book we call 'the C-Book' (C for creative). The main characteristics of this environment are:

- an authorable data-analytics engine and a graphical interface providing math and EE educational designers with the ability of customizing the kinds of information they need for assessing end-user creativity and the kinds of automated reactions they wish the tool to provide to end-users' activity.
- an authorable dynamic e-book infrastructure available to be used by the CoI members for collaborative design of innovative educational resources and by students to create their personalized versions of such resources, and
- a set of dynamic, exploratory and constructionist digital tools integrated in the e-book infrastructure designed to foster creativity in students' mathematical thinking.

The rationale is that within such an environment, math and EE teachers will have more

opportunities for richer design and knowledge co-construction processes exemplifying a boundary-crossing intercourse of their disciplinary domains and ending up in more creative productions (c-book units). The study is part of “M C Squared”(MC2) project, a three-year European-funded R&D project.

Virtual Presentations

Developing Historical Significance using Digital Technology: An example of Greek Ancient History

By Elias Stouraitis

Students usually define one common question which emerges in every history classroom: "Why we are learning this?". Every historical event incorporated inside historical textbooks is considered significant by students but not so important as to know it. Historians decide which events of the past are significant enough to research and afterwards which of them the educators will choose to teach inside classrooms. This research proposal aims to elucidate the ways in which sixteen years old students consider what is significant in their lives and what may change when they take place in a designed scenario about historical significance embedded digital technology.

Having in mind how to enhance historical thinking through historical significance in students are decided to use design research theory in terms of diagnose how students react in real educational conditions inside classroom. Peter Seixas' theory about historical significance will be used as a basis in this research. 24 students in an urban school near Athens will take place in a designed lesson about historical significance using the software "Inspiration". Firstly, students are asked to make a sketch about the most historical significance events in ancient period. They are possible to use words, pictures, icons etc. Then, they should make judgments and justifications about their responses. Students will note down the criteria which historians use in order to highlight an event or person as significant. They should understand the difference they choose an event as significant as the historians do. Secondly, an inquiry question about why city- state (polis – kratos) is so important to learn is posed to students and they have to make a diamond ranking involving historical events and persons that are related to city- state (polis – kratos). These events and persons are given by the teacher and are related to the designed lesson. Students should utilize the historians' criteria and write an article about their choice.

In conclusion, estimation about students' understanding of historical significance and particularly why they learn the city- state's (polis – kratos) appearance in ancient Greece will be useful in future use. At the same time, the software inspiration should be determined if could be used in these function and which are the consequences on student's reaction inside classroom.

Scaffolding for Inquiry Learning in Computer-Based Learning Environments

By Emily B. Moore, Mario Mäeots, Zacharoula Smyrnaiou

Inquiry-Based Science Learning (IBSL) as an innovative approach to science education situates learning in problem-solving activities or investigations of phenomena grounded in authentic science practices. Involving students in real science, technology, engineering, and mathematics (STEM) research entails engagement in complex situations that necessitate expert scaffolding and epistemological guidance to facilitate student learning. To address this challenge, computer-based learning environments have been developed and assessed on the quality of support they provide and their consequent efficacy. The virtual scaffolding designed into the learning environments is a major source of this necessary support, as scaffolding can determine the structure of the learning task, guide learners through key components of the learning environment and conceptual development, and shape their performance and understanding of the task in terms of the target disciplinary content and strategies.

With such a strong role in influencing student outcomes, we believe that scaffolding is an integral and essential component of effective computer-based learning environments. Unfortunately, there lacks consensus on the types of scaffolding available to designers of computer-based learning environments, the role of scaffolding types, and to some extent, the definition of what should be considered as scaffolding.

In this work, we seek to establish a common framework of scaffolding types and their outcomes as a grounded reference for researchers and designers of educational environments. To move towards this goal, we start by focusing on the following two research questions:
1) What types of scaffolding are designed into and emerge from different computer-based
learning environments?
2) How does scaffolding designed and integrated into different computer-based learning
environments support inquiry learning?

To address these questions, we compared three different computer-based learning environments: PhET Interactive Simulations (http://phet.colorado.edu), Young Researcher (http://bio.edu.ee/teadlane), and ETL E-slate Microworld (http://etl.ppp.uoa.gr/index.htm) – with environments being selected based on each authors' expertise. From these comparisons, we extracted a set of scaffolding types, some common to all environments, others individual to each. From our findings, computer-based learning environments can include scaffolding of the: Scope of Domain Knowledge (what content is addressed), Inquiry Pathway (the process through which content is addressed), Sequencing (the progression through the environment), Feedback (how the environment responds to student actions), and Cueing (orienting students within the environment). Examples of scaffolds within each type can be implicit (e.g., through placement of objects, or color), or explicit (using text). We describe each type of scaffolding with examples, and discuss ways in which the scaffolding supports student inquiry learning.

Refining a Revised Bloom's Taxonomy to Enhance Student Learning in Computer Science Courses

By Sofia Tzelepi, Isabella Kotini

Different educational taxonomies have been applied to the education domain of computer science for course design and evaluation, structuring assessments and comparing the cognitive difficulty level of computer science courses. The educational taxonomies are a valuable tool that could enable analysis and discussion of programming language courses assessment if it could be interpreted consistently. This paper reviews the literature on educational taxonomies and their use in computer science education, identifies some of the problems that arise, proposes a new taxonomy and discusses how this can be used in programming language courses. In computer science, Bloom's Taxonomy has been used to design rubrics for evaluating student performance on introductory programming courses, develop formative assessment questions at the appropriate cognitive level and inform course design. Nonetheless, there is significant need for more comprehensive assessment tools which can be easily used to assess student learning, guide development of teaching strategies, promote student metacognition in computer science, develop computational thinking skills and encourage the students's interest based on gamification philosophy. Our proposed taxonomy is based on the principles of the revised Bloom's Taxonomy. It classifies learning along three dimensions: cognitive skills (remember, understand, apply, analyze, synthesize and evaluate), learning progression (play, modify and create) and computational thinking behaviors (ability to communicate and work with others, confidence in dealing with complexity and persistence in working with difficult problems). A complete lesson would consist of a learning objective followed by computational thinking-based activities appropriate to the subject matter and learning task. The computational thinking-based activities used are drawn from three domains: modeling and simulation, robotics and game design and development. In the play stage of learning progression, students are consumers of someone else's creation. For example, they run experiments using pre-existing computer models, run a program that controls a robot, or play a ready-made computer game. The play activity focuses on the ability to play/use an existing "framework" to learn/inquiry/understand new *programming language concepts*. Over time they begin to modify the model/game with increasing levels of sophistication. Modify activity might include the ability to reorganize programming language elements/concepts into a new pattern or structure and to construct a code segment through the application of known algorithms. For example, a student may initially want to change the color of a game character or some other purely visual attribute. Furthermore, the student may want to change the character's behavior in a way that entails developing new pieces of code. Modification of this kind necessitates an understanding of at least a subset of abstraction and automation contained within a program, model or game. Through a series of modifications and iterative refinements, new skills and understandings are developed. In order to gain skills and confidence young student can be encouraged to develop ideas for new computational projects of their own design that address issues of their choosing. Create activity focuses on the ability to put programming elements/concepts together to form a coherent or functional whole, to devise an alternative process or strategy for solving a problem, to divide a task into smaller chunks in which they can apply known algorithms and processes and to construct a code segment or program from an invented algorithm. Within this "create" stage, all three key aspects of computational thinking: abstraction, automation and analysis, come into play. Students can maintain their sense of cognitive flow as they progress iteratively through a series of projects. In this context,

students tackle progressively higher design challenges as their skills and capacities increase. Activities that were once "too hard" and were anxiety-inducing become possible with appropriate, incrementally challenging experiences. Moving through this learning progression, it is important to maintain some elements of gamification that support student engagement and motivation. Our proposed taxonomy can be used as a general guide to aid teachers in developing, identifying and evaluating computer science-related activities representing the different levels of Bloom's taxonomy.

Study of the problem "exploration vs. exploitation" in the context of an ecosystem with the "many agent" software NetLogo

By Georgios Gkaras, Panayiotis Costaridis, Dimitris Yiatas

We meaningfully exploited biology class sessions devoted to the subject of "Energy flow in ecosystems through the trophic relations" and in particular the chapter relating to "Ecology" of the General Education Biology book, so as to introduce students of the 3rd year in the 1st model experimental general high school lyceum of Athens Greece, to simulations of complex systems with the "multi agent" software NetLogo. We have used the model "Ants", that is incorporated to this software, which simulates the problem "Exploitation or Exploration" for a colony of ants collecting food. We applied the "inquiry based learning" method while the course took place in the computer lab of the school and students worked in groups of two or three. Questionnaires were distributed, before and after class, opting to investigate the opinions, attitudes and knowledge of students about the objectives of this intervention. The overall process was critically observed and evaluated by our colleagues of both similar and different disciplines.

Following a short introduction of the problem and the NetLogo model, pupils had the chance to explore the computational model running it through its interface for several values of the input variables. Then they faced a certain challenge related to the exploration-exploitation problem, made a prediction, ran the program to get an answer, and finally they had time to reflect back on their prediction in relation with the answer they got. Moreover, during the one hour teaching session, they had the opportunity to experiment by altering the NetLogo programming code of the model.

Most of the pupils - who were of diverse orientations (scientific, technological, humanistic and artistic) – engaged enthusiastically in activities conducted during the class. They were curious and energetic and, as both their after class questions and their answers to the after class questionnaires revealed, they had enriched their knowledge about the nature of real world problems and some of them had obtained new interests in science and an enhanced self confidence in relation to their ability to understand and handle software.

The teachers who attended and evaluated the lesson expressed mostly positive feelings about the model, the lesson, the atmosphere in the class and the engagement of pupils but they also were critical about the relevance of the lesson to the curriculum and not certain about the associated knowledge gained as a result. However they were impressed, since they themselves also gained new knowledge, both in terms of science and in teaching, and some of them expressed their intention to try to use NetLogo models, related to their teaching subject, in their class.

Zebrafish (Danio rerio) as a Model System for Teaching Biology in School

By Eleftheria Argyrou, George Kakosaios

The zebrafish (Danio rerio) is a small (4 – 5 cm length), fresh water fish. It is a vertebrate that is widely used as a model organism in research, especially in developmental biology and genetics. The zebrafish possesses a variety of characteristics that make it a very useful system for the study of many topics in the field of biology. It is an organism that it is easy to be cultured with relatively low – cost materials. In addition it has a short generation time. After 3 months zebrafish are sexually mature. A single female, during mating and reproduction, can lay approximately 200 eggs per week. Zebrafish embryonic development is rapid. 24 hours post fertilization all major organs are formed and after 3 days the fish hatch and looks for food. The zebrafish embryos are transparent and develop outside their mother. In addition zebrafish transgenesis is efficient and its genome has been fully sequenced.

To our knowledge zebrafish is totally absent, from greek schools. Given the advantages of the organism which have been mentioned above, we propose the use of zebrafish for the study of organ systems such as cardiovascular and nervous system. The heart structure, the blood circulation and the pulse rate can be studied, even with school limited technical facilities, with a stereoscope and/or a microscope. Given that zebrafish embryos are transparent and they can be maintained in petri dishes, the observations and manipulations are easy for the students.

The previous rationale also applies to the study of the brain and neural network structure. Those studies can be performed with the utilization of zebrafish because its nervous system is relatively simple. Furthermore several mutants with motor deficits are available. The use of those mutants in behavioural tests can be proved effective tools for the establishment of projects related to locomotion and neural system development and function. In addition there are several transgenic zebrafish lines that show a tissue – specific expression of GFP (Green Fluorescent Protein). Those lines are very useful tools for the study of tissue structure and localization of the cells of interest by the observation of transgenic embryos under a fluorescent microscope.

In the present work we present a few ideas and data that focus on the usefulness of zebrafish as an ideal organism for the teaching of many topics in biology classes. The ideas are intended for students with ages ranging from 6 to 18 years old. We also focus on the utilization of zebrafish in the design of school projects.

The F1 in Schools programme in Greece: A case study

By Dimitris Polymatidis

The F1 in Schools is a worldwide multi-disciplinary challenge for pupils aged from 9-19, and one of the largest educational initiative promoting Science, Technology, Engineering and Mathematics (STEM). It is now in its 14th year of operation and has grown around the world operating now in over 30 countries. The present study evaluates the implementation of the F1 in Schools Challenge in Greece.

The challenge inspires students to use ICT tools to learn about science, physics, mathematics, aerodynamics, design, manufacture, branding, graphics, sponsorship, marketing, leadership/teamwork, media skills and financial strategy, and apply them in a practical, competitive and exciting way. The F1 in Schools makes a fundamental shift from a focus on teaching to focus on learning. It challenges students to learn through engagement in a series of real problems that students are likely to face as future professionals.

Besides using this initiative for teaching Science and Technology the formed teams are given the opportunity to compete regionally, nationally and internationally for the F1 in Schools World Championship trophy. Another one favorite aspect of F1 in Schools is its internationality – Perhaps no other student project operates in so many countries around the globe and brings together young people from so many different cultures on the same level. F1 in Schools enables two teams from different countries to combine their skills in collaboration and present themselves as one team to compete with national champions representing their Country at the World Finals.

Why F1 in Schools?
One of the greatest advantages of F1 in Schools Challenge is that students genuinely enjoy the process of learning. F1 in Schools Challenge is also unique in that it fosters collaboration among students, stresses the development of problem solving skills within the context of professional practice, promote effective reasoning and self-directed learning, and it aimed at increasing motivation for life-long learning.

F1 in Schools Challenge is not all about speed, competing student teams are also assessed and judged on the quality of their engineering, design process, innovative ideas, research and development work, resource management, portfolio, media skills, handling of sponsorship and verbal presentation of their work. The F1 in Schools uses Key Performance Indicators to assess the students in three broad areas: Applied Competence, Critical Thinking, Collaborative and Leadership Competence. Students also learn during the assessment, it is not simply a “grade” that is tacked on at the end of a paper.

Traditional classrooms, on the other hand, do not prepare students to work with other in collaborative team situations. Motivation in such traditional classroom environments is also usually low.

How Does the F1 in Schools Work?
The F1 in Schools Challenge is designed into a series of real-world, hands-on, problem-based learning investigations. Students will be working in small groups/teams with other students on problems that they are likely to encounter as a professional manager. Learning takes place within the contexts of authentic tasks, issues, and problems that are aligned with real-world concerns. In many respects the F1 in Schools classroom environment mimics the “real world”.

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