# COMPUTER BASED LEARNING IN SCIENCE

## Conference Proceedings 2012

## Learning Science in the Society of Computers

**Editors:**
**Roser Pintó**
**Víctor López**
**Cristina Simarro**

# COMPUTER BASED
# LEARNING IN SCIENCE

Proceedings

Learning Science in the Society of Computers

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**PREFACE**

Computer Based Learning in Science ’12 (CBLIS ’12) is the tenth in a series of international conferences that seek to provide a forum for researchers to present and discuss developments in computer technology aiming to assist learning in science and education. Papers have been accepted by authors working in science education at all levels together with papers by authors from other disciplines where the subject material offers transferability across disciplines.

The Proceedings contain the full text of the professionally refereed papers that were finally accepted for presentation at the conference and publication in the proceedings. The refereeing process operated in three stages:

62 abstracts were submitted for consideration – 1st refereeing process
55 authors were invited to present at the conference and submit draft manuscripts
33 papers were finally accepted for publication – 2nd refereeing process

The conference truly reflects international interest in computer based learning with 18 nations represented with a full coverage of all aspects of the topic.

A pleasing aspect and measurable success of the conference is the move towards jointly authored papers between contributors from different nations. These relationships have developed through collaboration between authors in previous conferences who see the benefits of sharing knowledge and expertise to the benefit of students worldwide.

The Conference Organizers would wish to see this develop further and are pleased to be the catalyst of good practice.

The Centre for Research in Science and Mathematics Education in Barcelona (Spain) is proud to host this conference.

To achieve the high level of presentation initially set at CBLIS ’93 at the Technical University of Vienna, Austria and reinforced at the Silesian University of Opava, Czech Republic (CBLIS ’95), De Montfort University, UK (CBLIS ’97), University of Twente, Netherlands (CBLIS ’99), Masaryk University, Brno, Czech Republic (CBLIS ’01), University of Cyprus, Nicosia, Cyprus (CBLIS ’03), University of Žilina (CBLIS ’05), University of Crete (CBLIS ’07) and the Computer Assisted Education and Information Technology Centre of Warsaw, Poland (CBLIS ’10), it has been essential to maintain a strong paper review body. The Conference Chairperson and the Editors wish to express their gratitude for the support and encouragement provided by the International Scientific Committee:

Philip Barker (University of Teeside, UK)
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Zacharias Zacharia, (University of Cyprus, Cyprus)

Most importantly, the Committee extends their thanks to all the authors who, in spite of busy workloads, have endeavored to meet the conference deadlines. The enthusiasm of the authors will guarantee the success of CBLIS ’12 and will continue to stimulate both developments in the field and joint projects to explore ideas between participants.

Finally, we would like to express our sincere thanks to the organizing committee without whom the conference would not have been possible:

Organizing Committee
Alba Masagué Crespi (CRECIM; UAB)
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Our final word of thanks goes to all the conference participants who continue to contribute to the evolution of this community of researchers.

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## NOTE FROM THE EDITORS

Since the first conference held in Vienna in 1993, the CBLIS has become an international forum to share and exchange ideas about teaching and learning Science with computers, to deepen the construction and development of new educational models and to elaborate contributions to both theoretical and practical in the field of computer-based Science teaching and learning. Throughout all the previous years, hundreds of researchers from dozens of universities from all continents have allowed to build around the CBLIS a consolidated network of people who have the philosophy to promote, through collaboration and exchange of experiences, the efficient use of computers in Science education. We understand that the computer science classroom has to become a tool to improve the current educational methods, bringing science to students and preparing them with better skills and abilities as future citizens of the knowledge society. Thus the CBLIS, throughout all these years, has forged their identity traits, addressing simultaneously science teaching and computers-based teaching. While there are several powerful international conferences devoted to science teaching and other dedicated to computers-based teaching, the conference CBLIS combines the two aspects as inseparable.

Furthermore, if in previous years the conference had titles such as *Integrating New Technologies*, now that reality has changed. These technologies are not new, and paradigmatically, the term NICTs has changed for ICTs. The computer and internet are not something futuristic, but they are already part of our lives (many children *digital-natives*). Additionally, the international conference CBLIS arrives to Barcelona at a time of global crisis and public debate on the role of innovation and research in the world. In the field of education - and specifically, the science education - we are at a point in the debate over the incorporation of educational technologies in classroom teaching and their use is more intense than ever, where we need to deeply reflecto on how to manage public investment to advance the digitization of the classrooms at all levels, and to find formulas for success that really involves improvements for teaching and learning science.

In the compilation of papers found in this document, many of these questions are arised, and through scientific rigor and educational innovation, right answers are sought, contributing to improve Science learning and teaching in the society of computers.

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### TEACHERS AND ICT: PROFESSIONAL DEVELOPMENT AND TEACHERS' ROLE



### VIRTUAL LEARNING ENVIRONMENTS AND E-ASSESMENT

**COMPTUER TOOLS FOR SCIENCE TEACHING AND LEARNING: GAMES, MUTLIMEDIA, SIMULATIONS, MBL AND VIRTUAL LABS**

# LEARNING TO LEARN SCIENCE TOGETHER

Z. Smyrnaiou, R. Evripidou

ABSTRACT
The Metafora project offers a pedagogical proposal based on online social learning to address such challenges as the decay of Mathematics and Science teaching and learning in Europe. During our Pilot study we examined the role of the platform's tools in assisting students' engagement in meaning generation processes as regards motion in a 3d Newtonian space. Moreover, the tools' role seemed promising in promoting collaboration and metacognitive skills such as planning. Nevertheless, further research is needed regarding the potential of the platform's tools to enhance the learning climate with an emphasis in collaboration which seems to be missing from our schools.

KEYWORDS
Learning to learn together (L2L2), inquiry-based learning, modeling, science, constructionist learning, visual language

## INTRODUCTION

The Metafora project, based on the Learning to Learn Together (L2L2) pedagogical concept, builds on Learning to Learn by shifting the focus on group, social, collaborative rather than individual learning. The use of the online platform's tools supports challenge-based learning, modeling and the constructionist approach in teaching and learning.

This qualitative study examines the role of these pedagogical tools in helping students engage in meaning generation processes regarding scientific concepts and methods. In our Pilot Study , 13-year-old students, with very limited prior knowledge of Physics, were asked to solve an open-ended challenge using three of the platform's tools.

They explored and built models of 2d and 3d motions and collisions, (de)constructing the 3d Newtonian space of the 3D Juggler microworld. It gave students the chance to operate in a complex, fun and engaging domain, working with complex 3D space concepts such as Azimuth, as they collaborated to address the challenge developing communication, strategic thinking and problem solving skills needed to build scientific meanings and concepts.

In Lasad, the platform's argumentation and discussion workspace, the students discussed their findings, negotiated and arrived at an agreed solution. Unlike common Web 2.0 social networking sites, Lasad helped them organize their learning and disseminate educational content, enhancing those social skills that pertain to intellectual growth.

To address the challenge, they collaboratively produced a plan of actions using the Planning tool. This plan, evidently demonstrating the use of the scientific method, helped them accomplish their tasks and provided valuable feedback for metacognitive, self-regulatory reflection.

Despite our findings regarding the role played by the tools in enhancing students' scientific meaning making the study showed that collaborative learning needs to be further cultivated in our schools before the students can fully exploit the potential of these tools. Moreover, it seems that the fact that there were too many cards available for them to build their plan was rather confusing. This fact coupled with the limited time available for familiarization with the tools rendered it difficult for the students to cooperate as efficiently as was hoped.

## THEORETICAL FRAMEWORK

Modeling has proven to be of great importance in enhancing students' reasoning and understanding of scientific concepts. Moreover, it is an inquiry-based learning process which coupled with the use of technology based educational tools can further contribute to this enhancement. These technology based tools can offer students the chance to explore, design and build personally meaningful computer models through which they realize their own conceptualizations and ideas as far as the scientific quantities and concepts studied are concerned. They have the chance to test their ideas using their models according to the constructionist approach. When created in collaboration with their peers, these models become the subject of discussion and reflection, a process which leads to further understanding of the scientific phenomena which lie behind them.

In our time and age computer gaming is a prevailing habit among students and an integrated part of their daily routine and interests. Game microworlds, specially designed to engage them in the study of academic subjects, take advantage of this reality in order to offer students the chance to learn in a way that is fun and familiar to them. Half-baked microworlds, as is 3D Juggler microworld, the one our students worked with in our study, are incomplete by design in order to work as idea generators and vehicles of scientific meaning making (Kynigos, 2007). This happens as the students using them can explore and (de)construct them according to their understanding.

Planning consists one of the three phases of cognitive regulation (along with monitoring and evaluation), and an element of self-regulated learning (SRL). As such, planning in science may be associated with the process of problem solving and in any case is a general domain metacognitive skill. There have been many research studies which have examined the self-regulated learning in a cognitive and social cognitive perspective. It is a process whereby learners think about their thinking (metacognitive process), take action in a strategic way (plan, monitor, evaluate personal progress) and therefore are motivated to learn. Emergent planning is of particular importance for researchers in the context of constructionist environments (Yiannoutsou et al., 2011). It is also considered a key tool which can guide students solve complex problems by finding strategic solutions (HUJI, Baruch). It is also seen as a means of representation, reflection, expression, communication and self-regulation.

In Physics we are particularly interested in what students learn as regards the scientific content and the scientific language besides problem solving. As far as scientific content knowledge is concerned, we know from relevant research that the scientific meaning making depends on the intuitions, the initial representations of students, the phenomenological descriptions, the descriptions of actions or events perceived as concepts and relationships between them.

## RESEARCH QUESTIONS

The following Research Questions were examined in the study:

- What is the impact of the Metafora Platform/learning on students' ability to conduct science inquiry & constructionist and overall, modelling and to use the inquiry skills of questioning, planning, implementing, constructing a model, concluding, arguing and reporting?

- What is the impact of the Metafora tools in orchestrating learning to learn together (L2L2) meaning generation processes and, more specifically, Physical concepts and scientific methods?

## RESEARCH METHOD-PROCEDURE

**Use of the Metafora tools**

After the short presentation of the tools, our students were given the Research Protocol (worksheet) with the warm-up and main challenges and were asked to "play" in the 3d Juggler microworld in order to familiarize themselves with it and be able to face the warm-up challenge first and the main challenge afterwards. They could use LASAD as a communication tool in order to discuss with the other subgroup of their team any issues needed in order to solve the challenge together. We briefly presented the discussion cards included in it. We emphasized that their ultimate mission was to work together on the Planning tool so as to present the plan they would follow in order to solve the challenge and showed them the different cards they could use in it to make their plan.

The two subgroups' work stations were far enough from each other so as to exclude their face to face interaction and to make the use of LASAD and Planning tool necessary for their communication.

Warm-up and Main Challenge stages:

- Warm up: "Keeping the blue and the green balls still, shoot the red ball vertically upwards".
- Main Challenge: "The balls should hit each other's base in a circular manner" (e.g. the red ball should hit the blue ball's base etc.)


Figure 1: The 3D Juggler microworld

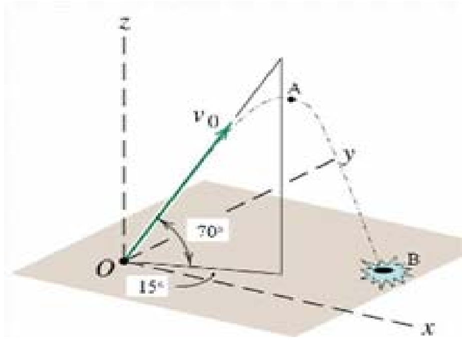


Figure 2: The role of the “Shot Altitude” and “Shot Azimuth” angles (70 and 15 degrees respectively in the drawing below) for the direction of the ball.

**Data collection**

The corpus of data includes a record of the students’ interactions with the digital tools as well as their verbal interactions as they worked together with the use of screen-capture software, as well as audio files from voice recorders, the students’ answers to the worksheets, their maps in Lasad and in Planning Tool and the researchers’ field notes.

**Description of the setting and participants in the pilot study**

This study took place in a public school, the 2nd Experimental Junior High School of Ambelokipi Athens.

The students who participated in the pilot study were four 13-year old Junior high School students at their second grade, with very limited formal prior knowledge in Physics as they had not been taught kinematics and projectile motion yet.

Four teachers/researchers took part in this phase of the study. The researchers' intervention was as limited as possible with the intention of letting students work independently. In this way they were given the chance to discover for themselves how to manipulate the 3D Juggler objects and variables and build their communication using Lasad and the Planning tool without any external influence. However, the students had to be oftentimes reminded to use Lasad, the discussion tool, to inform the other subgroup of their findings, progress or planned moves. The researchers' intervention was more obvious than it was planned to be in cases when the students' attention had to be refocused on the given guidelines.

**RESULTS**

Although the students manipulated the microworld's objects to solve the challenges, in the beginning they did so without really realizing the physical properties and concepts present in it. An example showing this is the fact that they decided to "play" with "gravity pull" (gravitational acceleration) in order to manage to keep the blue and green balls still as asked. One would have probably expected them to work this out in a different way. They were expected to zero the balls' initial velocity by zeroing "power" instead. They also wanted to manipulate "wind speed" and "wind direction" in order to carry the red ball to the direction they wanted instead of using the "power" and "shot azimuth", "shot altitude" to achieve this goal.

The students seemed confused by the fact that both the "Shot Azimuth" and "Shot Altitude" are measured in angle degrees and therefore couldn’t discern which quantity each of them monitors. Moreover, they didn't realize that they needed to isolate each variable, by changing its value and leaving all others unchanged, in order to see which quantity it represents. They finally managed to do so after several efforts and disagreements. It is also evident that the students thought that the mass affects the range of the shot. We assume this because we see that they change the value of the mass to achieve their goal probably thinking that the lighter the ball is the farther it will reach.

The students were unwilling to build a plan of actions before they really addressed the challenge in the microworld. Their plan was rather a report of actions they took to address the challenge. They communicated through Lasad during their efforts to address the challenge and afterwards in order to build their plan. Their comments on the cards of the Planning Tool show that they had realized the role of the physical quantities in the microworld and more specifically they had worked out that the direction of the ball on the horizontal level was defined by the value of "shot Azimuth", and that the combination of the Shot Altitude angle and the Power (initial velocity) defines the range of the ball. The cards they chose and the order they used them with shows that they approached the scientific method properly (Observe, hypothesize, experiment, conclude, etc.).

The collaboration between the subgroups was not always smooth. Subgroup B ignored subgroup A's comments although they later responded and finally managed to cooperate.

**CONCLUSIONS / DISCUSSION**

The students had to work with and understand deeper the physical concepts and quantities which have to do with projectile motion in a Newtonian space in order to address the challenges. Due to the fact that the microworld was a 3D environment they were able to generate meanings about simple Physical concepts and quantities e. g speed, power as well as complex ones e. g Azimuth. The students engaged in the (de)construction of the microworld while at the same time they were offered open-ended challenges. Their approach to the challenges was creative and alternative. For example, when one of the subgroups managed to address the challenge by making the red ball hit the blue ball’s base following linear motion on the horizontal level, they decided to reject it because they didn't consider it spectacular enough. They wanted to make it “fly” towards the target (projectile motion), which they eventually achieved.

The two subgroups were led to reconciliation and collaboration after they had erased each other’s cards on their Planning tool map and destroyed the whole map. They rebuilt their plan together and started all over from the beginning. This incident shows that the tools rendered their collaboration absolutely necessary and gave them the chance to realize its importance.

They gained deeper understanding of scientific concepts and the relations between them by experimenting with motion in the 3D Newtonian space of the 3D juggler microworld's environment.

Consequently, they had the chance to Learn to Learn Together (L2L2): how to collaborate, how to plan their moves, how to argue, scientific concepts and physical quantities, scientific methods and approaches

Nevertheless, there are some findings that pose questions and considerations as regards possible changes and improvements to be employed in the future main study:

First of all, the students seemed reluctant and unwilling to share their findings with their mates and in many cases did so only because they were asked to do so by the researchers. The admittedly great number of cards in the Planning tool seemed to cause confusion about which of them to use to construct their plan. They could not plan their actions ahead before actually experimenting and addressing the challenge first. They used the same cards repeatedly and in some cases, added text the content of which was irrelevant to the cards label.

Taking the above into consideration, we will have to address these issues in the future main study by taking the following steps:

We will allocate more time for the familiarization session during which we will give students readymade sample models of both argumentative discussions and plans in Lasad and Planning Tool respectively. This will hopefully help them realize the use of each card in them. The issue of collaboration and feeling comfortable with sharing questions, findings etc. with others may also have to do with the lack of a school culture of collaboration. Admittedly, our schools encourage competitiveness more than collaboration. This fact makes it even more necessary and urgent to introduce such tools as the ones our study presents, in order to help emphasize the need for collaboration and togetherness in learning.

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