Co-funded by ERASMUS+ Program of the European Union, Key Action 2Project: 2016-1-RO01-KA201-024518, "Discover Real Everywhere Applications of Maths – DREAM"
Beneficiary: Colegiul National "Constantin Diaconovici Loga", Timisoara

Guide to Erasmus+ KA201 DREAM Project Practices For Educators

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1. Learning and teaching Mathematics with Moodle-based E-learning environments, combining content in the fields of Architecture, Physics and Robotics

The problem: Can mathematical teaching/learning of today be attractive and efficient?

This problem was faced by three cooperating schools: "Constantin Diaconovici Loga" National College of Timişoara from Romany, Agrupamento de Escolas Soares Basto from Portugal and 1o Geniko Lykeio Aigiou from Greece, as well as "Tibiscus" University of Timişoara from Romany - the university partner, within the project Erasmus+ Key Action 201 "Strategic Partnership", "DREAM - Discover Real Everywhere Applications of Mathematics".

The main aim of the project was putting into practice innovative methods and techniques of teaching mathematics with the use of a modern tool which is the educational platform MOODLE, along with the use of innovative methods and techniques using multimedia technologies and ICT, elaboration of materials related to daily and scientific application of mathematics and formation of a series of e-lessons, in which students and teachers from cooperating schools take part, but also any teacher interested in modern mathematics education can benefit from it (all materials are accessible in English version in http://srv-1lyk-aigiou.ach.sch.gr/moodle/).

Math teaching is effective and attractive because MOODLE

platform allows participants to prepare, gather, share didactic materials, participate in discussions, organize group work, evaluate effects of teaching and monitor the whole process. Mobile version of the platform with the application for smart phones allows any person who is interested and motivated by the modern tool to gain new math skills and gather math knowledge in any place and time and to begin his/her educational adventure.

Our publication is a kind of a guide for teachers who will be eager to take advantage of the attractive and effective way to improve their math education. We are convinced that our actions have fit in the needs of modern math didactics, the needs of contemporary math education based on practical abilities and knowledge. We would like to thank warmly our partners – principals, teachers and students from Romany, from Portugal and from Greece, all evaluative participants, co-creators and observers of our actions.

2. What is the DREAM PROJECT?

Connecting Mathematics to everyday life gives it a purpose and a meaning. Students tend to ask: "Why do we have to study this?" In order to avoid it, we can try to show them how Math can be applied to other sciences, such as Physics, Architecture, Art, Finance, Sport and Nature. There are many different ways you can bring the real world into your Math classroom. In DREAM project we explore the most challenging and demanding one, but at the same time the richest and the most rewarding: project-based learning. We explore ways of how a Math class can be turned into a cross-curricular project that allows students to apply Math

skills in a meaningful way, allows them to see where Math is used in the real world, highlights careers where Math is used, and develops a range of essential skills such as collaboration, presentation, creativity, etc.

We also explore simpler approaches, like textbooks' feature activities that give examples from real-world situations. The problem is that these situations usually remain very abstract for the students, and the question that is asked of them merely functions as an excuse to apply a certain set of integers into a formula of sorts. We want to make these questions more real and tangible for the students. We wanted to take our students outside of the classroom to make some observations and ask some questions which they would like to answer.

Whatever approach we use, the important thing is that students are interested in finding the answer to the Math problem as it has meaning and purpose for them.

Our Learning Objectives for DREAM project were:

1. Provide project-based learning examples that can help make Maths more meaningful and result in deep learning in a Maths context
2. Transform some normally boring activities found in textbooks to become more "real" and engaging to the students
3. Incorporating some key reflections of teachers dealing with the implementation of Math activities

In particular, the idea of DREAM (Discover Real Everywhere Application of Maths) project

was the development of Math e-lessons for 6 sectors (Finance, Sport, Nature, Art, Architecture and Physics). The e-lessons were designed by students and teachers together. The activities of e-lessons involved experimentations, hands-on tasks, outdoor activities and mobile software applications.

The partners of DREAM project are:

1. National College "Constantin Diaconovici Loga" Timisoara, Romany
2. 1o Geniko Lykeio Aigiou, Greece
3. Agrupamento de Escolas Soares Basto, Portugal
4. University Tibiscus of Timisoara, Romany

Real-life applications of Maths give motivation to students to study Maths, since it's clearly shown that Maths is not only theoritical but also have so many everyday practices. Moodle platform allows students to access the e-lessons anytime and from anywhere. Moodle also facilitates math teachers to have better control of their students' activity.

3. E-Learning

E-Learning environments may contribute to the teaching and learning process of mathematics if the integration is done within the framework of proper pedagogy. Building customized E-learning programs places high demands on design, programming skills, and time. An alternative to this can be deployment of courses within learning management

systems. One such system that has been gradually gaining worldwide popularity is Moodle (Modular Object-Oriented Dynamic Learning Environment), a course management system for online learning. Moodle is "open source", allowing developers to tailor the system to individual needs. It also communicates extremely well with many web-based resources (Facebook, YouTube, Wikipedia, Hot Potatoes, etc.), allowing developers creativity and versatility.

The design of Moodle is based on socio-constructivist pedagogy. This means its goal is to provide a set of tools that support an inquiry- and discovery-based approach to online learning. Furthermore, it intends to create an environment that allows for collaborative interaction among students as a standalone, or in addition to, conventional classroom instruction

In this guide we present an overview of three (3) E-learning environments that we have implemented using the Moodle platform during the Erasmus+ KA201 project DREAM. These environments include interactive activities combining simulations, short videos, virtual experiments, games and more, in order to enhance interactive learning of mathematics based on constructivism theory, and allow for students and teachers to learn skills for intelligent use of information and technological communication. The environments have been developed in partnership with math teachers of cooperating schools, as an enhancement to face-to-face teaching, for both curricular and extra-curricular learning. One main advantage of these environments is the freedom of teachers to add, change or use them as is, according to their needs; hence, the teachers are equal partners in the development. We will also show how these

environments supply teachers with many interesting tools that can be used to improve the teaching–learning process, and the students to reinforce their abilities and knowledge in maths, in a user friendly and stimulating manner engaging them in a fun, familiar and modern environment.

4. Moodle

Nowadays, the computer is a significant part of the learner's daily life. It is, by now, inevitable that methods of teaching and learning should include E-learning components that are based on the computer environment and include proper preparation for the 21st century which requires a "new pedagogy" (Martin and Madigan, 2006). This new pedagogy, in the case of math teaching and learning, employs:

- High-order thinking and learning skills.
- A constructivist approach to teaching and learning.
- Information, communication, and scientific literacy skills using digital means and advanced technologies.

Teaching in an E-Learning environment can contribute to the ability to teach, the ability to learn and most important to bridge between two main components in the classroom, the teacher and the learner. E-learning provides different environments for learners with dynamic, interactive, nonlinear access to a wide range of information (text, graphics, and animation e.g. Jonassen, 1996; Jacobson & Archodidou, 2000) as well as to self-directed learning in online communication (e-mail and forums).

E-learning is based on concepts such as independent learning, active learning, self-directed learning, problem-based education, simulations, and work-based learning (Martens, 2004). Most of these models are based on constructivism in which, according to Reiser (2001), learners become responsible for regulating their own learning process. Self-regulated learners are motivated, independent, and meta-cognitively active learners in their own learning (Duffy et al. 1993).

All these instructional models hold that it is crucial to generate the learner's motivation (Martens, 2004). For this reason, many of the computer-based learning environments constructed present realistic problems, for example through a simulation or a game. Ryan and Deci (2000) distinguish between extrinsic motivation, which refers to the performance of an activity in order to attain some separable outcome, and intrinsic motivation, which refers to doing an activity for the inherent satisfaction of the activity itself. The effort or motivation on which constructivist e-learning environments try to rely is typically intrinsic motivation, with its associated features such as curiosity, deep level learning, explorative behavior, and self-regulation. Research has shown that intrinsically motivated students show more behavior that can be described as explorative, self-regulated, aimed at deep level processing, and aimed at exploration and reflection (e.g., Ryan & Deci 2000). To increase the understanding of the relation between e-learning and motivational processes, it is necessary to gain a better understanding of learning materials that are developed to increase motivation (Martens, 2004).

Moodle allows the integration of a wide range of resources, from chats and forums to online booklets, a variety of

questions, collections of problems and exercises, lecture notes; including any kind of text-based or Html-formatted documents, multimedia resources such as graphics, video or audio (e.g. MP3 files), PowerPoint, or Flash-based applications and Java applets (Godwin-Jones, 2003). Moodle focuses on giving educators the best tools to manage and promote learning and allows teachers to organize, manage and deliver course materials.

From a didactic point of view, the usage of multimedia tools to create attractive activities makes the learning process friendlier for students. As a consequence, these activities increase the interest of the students in their studies. Teachers can provide students with a large amount of resources that they cannot usually show in the classroom due to time constraints. Lesson tasks within Moodle can be linked to any resources that are uploaded to one's server or that are available on the Internet. The students' exploration of any of the content-based resources can be easily assessed by using any of the Moodle based evaluation and feedback tools. Moodle is quite powerful in content creation due to its built-in HTML editor. The degree of expertise required is essentially the same as for any word processor. More sophisticated presentations such as animations or text-specific feedback provisions need to be created using exterior multimedia authoring programs. These materials cannot be added in a hard copy booklet.

Moodle has pedagogical advantages since it was built in accordance with the teaching approach which emphasizes the construction of knowledge through active and interactive learning, and learning multi-sensory experience through multimedia. The design of Moodle is based on socio-constructivist pedagogy (Brandl, 2005). This means its goal

is to provide a set of tools that support an inquiry and discovery-based approach to online learning. Furthermore, it intends to create an environment that allows for collaborative interaction among students as a standalone or in addition to conventional classroom instruction.

In our school, 1o Geniko Lykeio Aigiou, a general purpose upper secondary school committed to the promotion of science and math education in Greece, Moodle serves as the primary learning platform for online learning. Over 5 online math, science and technology courses have been developed with over 300 school students participating in them annually. We have adapted Moodle for technology, science and math teaching and learning and added many features, making it a technologically and pedagogically advanced platform.

In this guide we present three of our Moodle based courses, "Math-in-Architecture", "Math-in-Physics" and "Math-in-Robotics", which include an array of activities that combine higher-order skills with content in math, science and technology for upper secondary school students. In addition, we report on a pioneering attempt to run and evaluate them among teachers and students. We will demonstrate how these environments provide the teacher with many interesting tools to improve the teaching – learning process, and encourage students to reinforce their abilities and knowledge, in a user friendly, stimulative manner.

5. Development of E-learning courses on the Moodle platform

To design the environment we were based on the TPCK model (Koehler, Mishra & Yahya, 2007), which is a framework designated for the three aspects of teacher knowledge and transforming them into design aspects, namely, Technology, Content and Pedagogy as shown in Figure 1(Lachmy et al 2012). Technological design refers to the technological tools implemented in the environment and the manner they are adapted to specific requirements. Content design refers to the way the content is integrated with the technological tools and includes task design considerations. Pedagogical design refers to the interrelations of different users (such as teachers and students) and related factors (such as schools) with the environment.

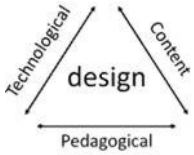


Figure 1: Design model (Lachmy et al 2012)

6. Used Methods of Moodle for Working-out Electronically Learning Course

MOODLE has the widest range of opportunities to work-out high-quality interactive e-learning courses, and full

implementation of the learning process in an electronic environment, including:

- Various options for formation and presentation of educational material,
- Testing the knowledge and control of progress,
- Communication and organization of the student community.

Moreover, all the basic options of MOODLE system were developed with a focus on the pedagogy of social constructivism, which means the active involvement of students in the process of knowledge formation and their interaction with each other. Although the system is intuitive and simple enough to use, it enables teachers to implement creative projects of different complexity levels. The main advantages of using the MOODLE system in the learning process are the following:

- the best possible adaptation of the educational process to the age and the individual cognitive abilities;
- control of the educational process and, especially, the process of information assimilation: at any time it is possible to make corrections by the teacher;
- providing the student condition of psychological comfort, as in the study of new material, and in the control of acquiring knowledge and skills;
- "openness" of the informational field: the volume and the level of training information can be any high;
- unlimited opportunities to use a variety of teaching methods. (Андреев et. al. 2008)

The basic idea of MOODLE is not connected with the abandonment of traditional forms of learning. On the contrary, the possibilities of the electronic media are used in addition to existing forms of education, creating two formats of study: mixed or distant.

Let's look at some examples:

Passive method

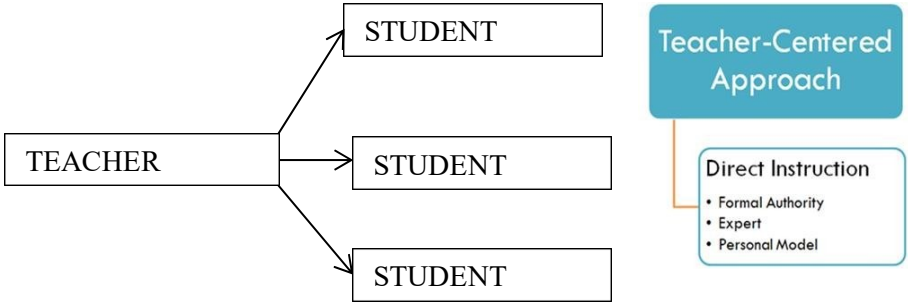


Figure 2. USC, School of Education © 2014

" + "

All materials are available in one place
A student can study according to his acceptable place, time and tempo
It is convenient for a teacher to follow and to manage each achievement

" _ "

Students are passive performers
A teacher has an authoritarian working style
A low motivation

Active method

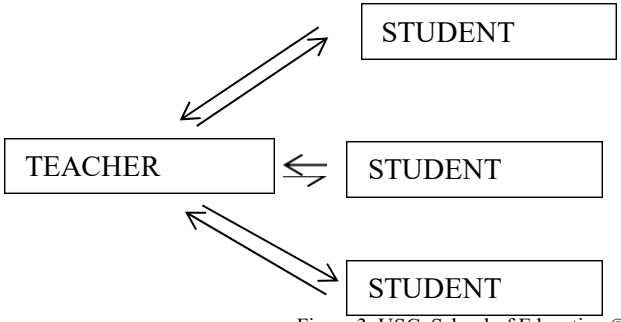
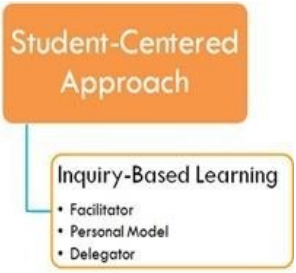


Figure 3. USC, School of Education © 2014



" + "

Students' participation
It is convenient for a teacher to follow and to manage each achievement
All materials are available in one place
A student can study according to his acceptable place, time and tempo

" _ "

There is no students' cooperation
Some students are still passive

Interactive method

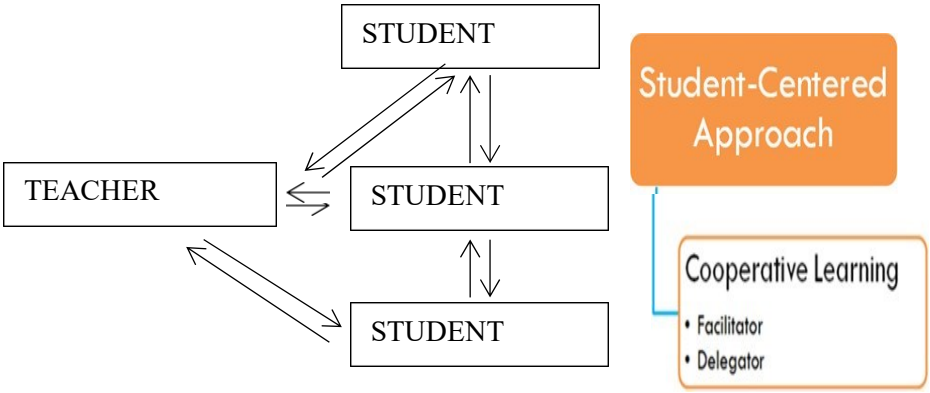


Figure 4. USC, School of Education © 2014

" + "
Students communicate with each other, experience exchange
Students learn how to cooperate
Students' activity dominates
All materials are available in one place
High motivation
A student can study according to his acceptable place, time and tempo
A students is learning continuously and a teacher is perfecting himself all the time

" _ "
There is no students' cooperation
Some students are still passive.

Active and interactive methods are obvious. They change the teaching process, the teacher and student roles. Interactive learning - is primarily dialogue learning. From

the impact of object, the student becomes the subject of interaction; he is actively involved in the learning process. The features of this cooperation consist of:

- joint immersion in the problem field of the solved task, so the student is included in a creative space;
- agreement of the chosen implementation means and methods of solving the tasks;

Joint activity means that each individual makes his own special contribution; there is an exchange of knowledge, ideas, and activity variants. This happens in the atmosphere of goodwill and mutual support, which allows obtaining not only new knowledge, but also develops cognitive activity, improving it into higher forms of cooperation and collaboration.

When using interactive methods the teacher does not provide ready-made knowledge, but encourages students to independent search. The activity of the teacher gives the way to the activity of the students, and the task of the teacher is to create conditions for their initiative. Teacher refuses the role of so called filter with the selected learning information, but serves as an assistant in the work, one of the sources of information. Interactive learning is widely used in intensive training.

To learn and use these methods, the teacher must know the different methods of group interaction. Online learning provides an understanding, cooperation, mutual enrichment. The main advantages of interactive forms of learning:

1. Students learn the new material not like passive listeners, but as active participants in the learning process, which reduces the part of classroom load;

2. Students acquire skills to use modern technical facilities and technologies of the information processing;
3. Students acquire the ability to find independently the information and determine the level of reliability;
4. Relevance and efficiency of the received information; students are involved in problem solving - opening their minds;
5. Flexibility and availability. Students can be connected to educational resources and programs of any computer in the network;
6. The use of such forms as e-tests (interim and final), enables a clear administration of the educational process;
7. Interactive technologies give the opportunity of constant contacts of students with the teacher. It is important to understand that the use of network resources should not exclude direct contact with the teacher and students among themselves.

Using interactive forms of learning involves modeling life situations, the use of role-playing games, joint problem-solving. Creating a course, the teacher can include in the content any number of resources (text pages, web pages, links to files, directories) and any number of active elements. At the same time, for all elements of the course, it is possible to make evaluation, including scales made by the teacher himself. All evaluations can be viewed on the special page of the course evaluation.

The learning process using interactive forms has several advantages, allowing realizing the basic methodological principles:

- considerable motivational potential;
- confidentiality;
- a high degree of learning interactivity than the work in the classroom;
- lack of fear of making a mistake;
- the possibility of multiple repetitions of learning material;
- modularity;
- dynamic access to information;
- free access;
- presence of a constant active referral system;
- the possibility of self-control;
- compliance with the principle of developing training;
- individualization;
- ensure the visibility and multiplicity of information.

All of these mentioned features help to solve one of the major challenges of modern education - formation of students' critical thinking and communicative competence. It's clear that you should control not the person, but the process of his development. Students should be taught to search, interpret, compare, critically evaluate, discuss, and express their opinion, to justify it, to make choices, to take a decision and to implement it into their lives.

7. Short Review of Interactive Learning Methods

Methods are used by teachers to create learning environments and to specify the nature of the activity in which the teacher and learner will be involved during the lesson. While particular methods are often associated with

certain strategies, some methods may be found within a variety of strategies.

Capable instructors are aware of the principle of active learner participation. "Given the choice between two techniques, choose the one involving the learners in the most active participation". Below is a sample of techniques categorized according to participant involvement.

Levels of Learner Involvement

Low Involvement	*Medium Involvement*	*High Involvement*
Lecture Panel discussion Demonstration Computer – based drills Computer – based tutorials Socratic dialogue Tutorials	Group discussion Behavior modeling Observation Reflective practice – blogs, journals Asynchronous online forums E-mail and listservs Audio/Video conferencing 3D Interactive Learning activities	Role play Debates Case studies Simulations WebQuests Internet searches Concept mapping Trial and error Storytelling Jigsaw Educational gaming Second Life – Sims Real – time relay chats In – basket exercises Structured experiences Problem – based learning Project – Based Learning Collaborative Learning Inquiry Learning

Table 1. Techniques categorized according to participant involvement

http://teachinglearningresources.pbworks.com/w/page/19919560/Instructional%20Approaches

In order to achieve the best results, it is important to understand and manage Moodle resources, activities and a full knowledge of methods and techniques.

8. Math In Architecture (MIA) e-course

"Math-in-Architecture" (MIA) was a project initiated 5 years ago targeting our secondary school students who are high achievers in math, teaching them extracurricular math topics related to architecture. The program was a correspondence project that connected students and mathematicians through a series of booklets sent to selected students through regular mail. In 2014, the program was transferred to the internet and correspondence was done via online forums. The booklets were available as PDF files which participants downloaded and then sent in via fax or mail. The Math-in-Architecture staff reviewed the work done by the students and returned the marked booklets via regular mail. Within DREAM project, the program has undergone another major transformation by implementing it with the Moodle platform (see Figure 5).

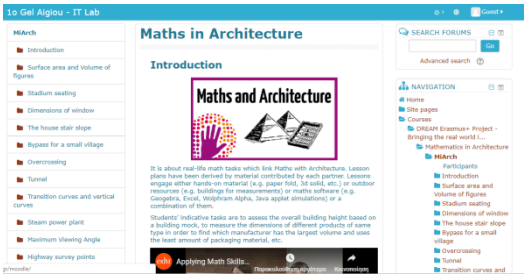


Figure 5: "Math in Architecture" e-course in English

The transformation was made possible because of the capabilities of Moodle: online wide range system support, 24 hours availability, a variety of network interfaces (Internet explorer, Google Chrome, FireFox). This change enabled enhanced communication with the staff at our school, and, more importantly, a completely interactive online booklet, submitted and reviewed online with no hardcopies necessary.

Another important change was the feedback capability. Checking the booklets by students and then sending the marked booklets via regular mail takes a lot of time, hence, a lot of patience is required from participants. Students who participate in E-Learning environments often complain about the lack of feedback that is available in conventional classroom settings. In Moodle, almost all modules are designed to allow teachers or course participants to provide feedback in qualitative or quantitative form. For example, both the journal and assignment module gives the instructor the option to provide their comments in a feedback box. The assignment module, which is designed so that students can upload their assignments in any file format to the server, also allows the instructor to upload comments about the student's work in the form of text- or audio-based (e.g., MP3) files. Feedback can be teacher-restricted or made accessible to all participants in both forums. Closed questions in MIA are evaluated automatically using the instant feedback feature. If the booklets include also open questions, the instructor can review and comment on each assignment and even send a personal mail with feedback on the overall booklet. The feedback is given for each student at his or her pace. The ability to monitor each individual student from amongst a

huge number, providing them with the right feedback at the correct time is one of the most advantageous features of Moodle.

MIA offers talented and curious children (grades 10-12) extra-curricular activities in recreational mathematics that develop their creative thinking and logic. Activities include a lot of in-depth topics (e.g. surface area and volume of figures, stadium seating, dimensions of windows, golden ration, etc.) that are spread over the school-year and, once uploaded, can be accessed anytime online, to be done at home or at school. The in-depth topics are exciting, challenging and, most importantly, fun because it is based on the ideal combination of content, pedagogy and technology. The Moodle platform enables this by allowing integration of a wide range of resources; online booklets, a variety of questions, collections of problems and exercises, lecture notes; including any kind of text-based or Html-formatted documents, multimedia resources such as graphics, video or audio (e.g., MP3 files), PowerPoint, or Flash-based applications and Java applets.

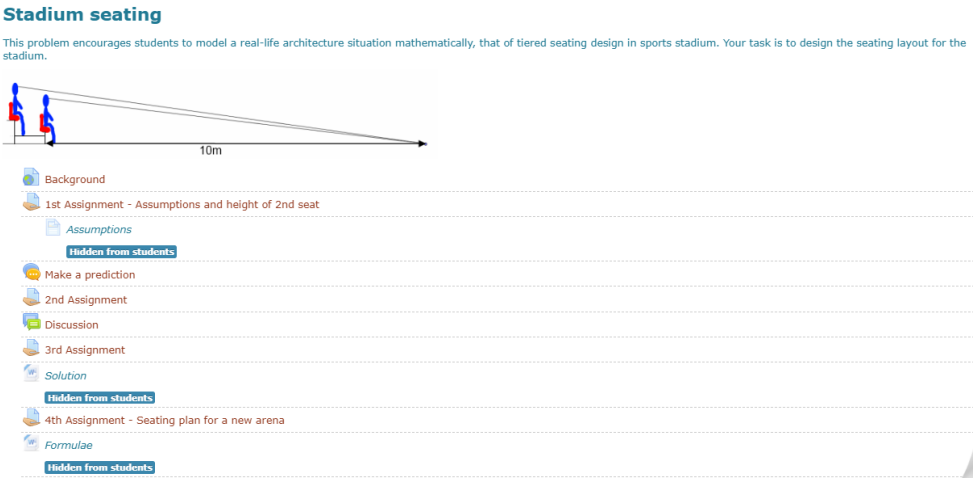


Figure 6: Stadium seating topic in MIA e-course

In addition to the in depth topics, participants may have chat with the MIA teachers at the school (see Figure 5). The chat is a unique opportunity for participants to have a conversation, share their ideas and get feedback from teachers.

The Forums and especially the weekly chats eased the interaction with students in real-time and facilitated interaction on an even level allowing students to share their opinions and suggestions; as a learning community, it allowed students to share and discuss their knowledge and difficulties, and also help each other. We noticed that at the beginning of the school year there were few students who participated in the chat, over time the number of students who participated increased and more importantly there was an increase in the number of active

students who asked questions and contributed to the discussion.

There are two options for participation in the project: as an independent participant or as part of a class. In the latter case, in addition to the staff, there is a math teacher that follows the students' activities. The Moodle as a learning management system allows the teachers to view the answers, see the dialogue in the forums and chats and this enables teachers to understand in which part of their course students are experiencing the most difficulties and which parts are easy.

We note that the number of students using internet courses (such as "Math in Architecture"), preferring them to hard copy assignments and booklets, increases over time, which suggest that students have interest in such E-Learning techniques. Last year when we implemented the program in Moodle only 50% of the participants used the internet course, while this year 90% are using the online course. Next school year we intend the program to be a fully online program without any hardcopy booklets. Overall, the perception of students of web-based homework testing was very positive. We implemented a similar Moodle course in Science, "Maths in Physics", with similar results.

Evaluating MIA environment: MIA course of 2017-2018

The evaluation was a short-term assessment conducted at the end of the period in June 2018. During the evaluation:

1. Questionnaires were distributed among the students (80 questionnaires were

received from MIA participants).
2. 16 parents were interviewed.
3. 8 teachers were interviewed.
4. Focus groups were set up and conversations with students were conducted

Questionnaires were distributed to all the children we were able to reach, and most of them filled in and returned the questionnaires. Parents and teachers were selected at random – based on accessibility and the time we had available to us. The findings derived from student questionnaires and from the interviews with parents and teachers.

Student, parent and teacher satisfaction indicate a high level of satisfaction. The students liked the program and its contents to a very large extent. They liked the level of organization to a large extent. Students' satisfaction with the program found expression in their almost universal willingness to recommend the program to others and their almost universal willingness to remain enrolled in the program. Parents and teachers felt that the program is an enriching and innovative one and has a good reputation in general. Many of the teachers have been acquainted with the program for last year and have chosen to continue their involvement with it because of its quality. Teachers commented that the program provides a response to the needs of a unique group of students.

The essence of the program as perceived by the students is shown in Figure 7. The students experienced the program from two almost equal perspectives - they perceived it both as fun, and as educational and enriching - a combination of fun, information and interest in both

programs. It seems that the program was able to combine a fun experience with the gaining of interesting knowledge. 11th grade MIA students said: "It is challenging because it is hard. It is not something mundane … there are questions of a different sort- questions that are, let's say, surprising". Other students emphasized the innovative aspects of MIA and that the learning was meaningful rather than technical: "I learned about architectural things related to maths that I did not even know existed. Had you asked me who Fibonacci was, I would have said he was an artist, I had no idea what operators were". "If someone were to just tell me to write up a list of Fibonacci numbers, I suppose I might not remember how to do that, but if I were to get the first four numbers in the series and told to continue the series, I'd remember what to do…"

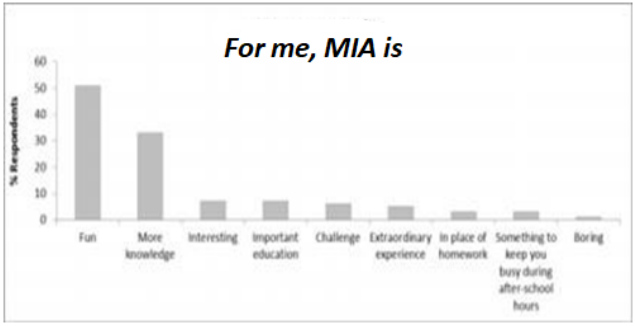


Figure 7: Distribution of student responses to an open question: "For me, MIA is…" % of students indicating each of the responses

Implementation of Math In Architecture (MIA)

"Math In Architecture" (MIA) offers school-children in

grades 10 to 12 a glimpse of the mathematics involved in cutting edge field of architectural design. The program includes four in-depth topics, each from a different architectural field. The in-depth topics are spread over the school-year and once the activities are uploaded, they can be accessed online anytime, at home or at school. The activities are based on simple tasks that can be performed at home, which lead to a much better understanding of complicated ideas and, equally important, to the process of architectural and math thought. The tasks are discussed and results compared in the weekly chat with the MIA team, math teachers at our school. The chat is a unique opportunity for participants to have a conversation, share their ideas and get feedback directly from math teachers of school.

9. Math In Robotics (MIR) e-course

Another course we implemented in Moodle platform is Math in Robotics (MIR)". The program is engaged in solving challenging problems of interesting and intriguing in a variety of topics in educational Lego robotics. The purpose of the program is to create a foundation of basic understanding of mathematics used in robotics, development of personal abilities, better ability in solving problems and strategies selection. The program encourages computational thinking and creative and intelligent use of math and robotics technology. In the MIR program a team of computer science teachers from our school write the questions for the challenges. The participation in this program can be also as an independent participant or as a member of a class. Next year we intent to encourage the

participants in this course by adding a competition between schools and by adding practicing lessons within school classes supervised by computer –science teachers.

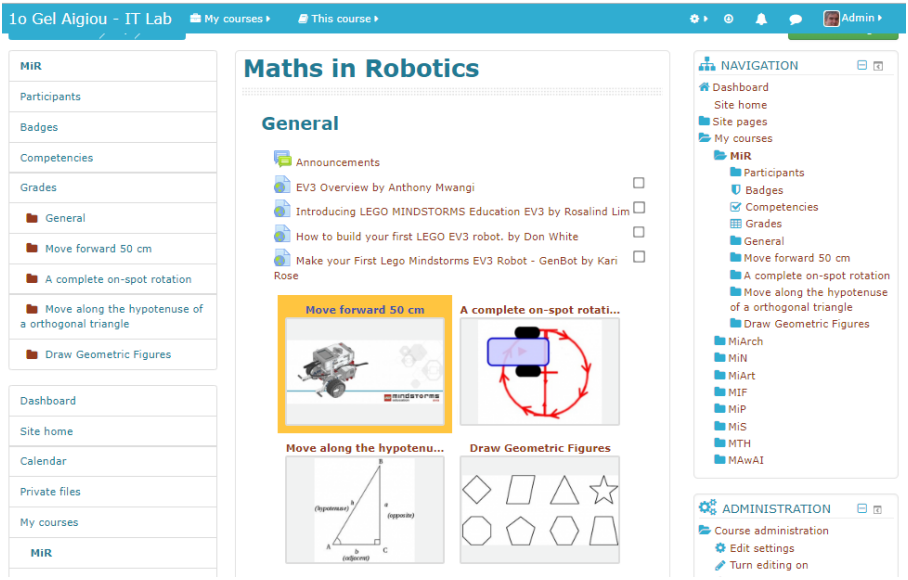


Figure 8: Maths in Robotics program

10. Maths In Physics (MIP) e-course

MIP includes an array of activities that combine higher-order skills with content in math and physics to upper secondary school, emphasizing learning and thinking skills such as asking questions and exploration. The MIP environment has been developed together with math and physics teachers as an enhancement of face-to-face

teaching. The content of the units were chosen by a team of math and physics teachers (content which was difficult to teach) and various activities were built in collaboration with them. The uniqueness of these environments is the freedom of teachers who teach with them to add, change or use them as is, according to their needs. Additionally, we developed and fitted tools according to the teachers' needs for use in MIP based on Moodle. MIP consists of the following components:

- Visuals that combine short films, simulations, animations, and educational games related to the selected physics topics.
- Interactive learning activities that support attaining high-order thinking and learning skills combined with scientific content.
- Feedback facilities that enable automated response regarding closed questions as well as teacher's reactions to open-ended tasks.
- Learning management system options that facilitate assessment of learning through questionnaires, statistics, and reports.
- Flexibility for teachers: they can adapt the activities to their needs or the needs of their students and according to class technological conditions.

The first unit we developed in MIP emphasizes learning and thinking skills such as asking questions and exploration. These skills were incorporated on the subject of “projectile motion" in various aspects: projectile motion with an initial horizontal velocity, projectile motion without initial horizontal velocity (these aspects are part of the science curriculum in upper secondary

school). The students visually explore and experience projectile motion phenomena such as a car moving at 20 kilometers per hour and one person drops a ball from a height of 0.70 m above the top of a bucket or the angry birds game simulation. The computerized activities are structured, yet flexible, and lead to a variety of investigation-oriented activities through science films, games, and simulations as seen in Figure 9. The teacher acts as a mediator and helps the students navigate according to their capabilities.

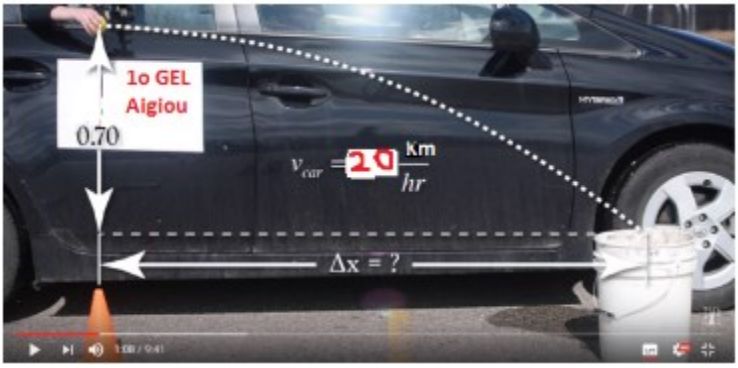


Figure 9: A dynamic presentation of the model of a car moving at 20 kilometers per hour and one person drops a ball from a height of 0.70 m above the top of a bucket (projectile motion)

Pilot evaluating MIP environment: first unit - exploration skills incorporated on the subject of "projectile motion".

A pilot program was run with teachers and students who used MIP as part of learning this topic in their physics sciences lessons. The topic "projectile motion" is usually studied in the last semester of 10th grade or at the beginning of 11th grade. We administered questionnaires

to students who used our environment (3 classes, N=57). The questionnaires included Likert-type items in evaluation scale of 1-4 (1- Not at all, 2 – Slightly, 3 – Much, 4 – Very much) as well as open-ended questions about the E-learning environment, MIP. (Answers to open- ended questions were tested and classified by category using Shkedi 2003). The purpose was to examine students' attitudes toward the different dimensions of learning in the MIP environment: The intention was to find out, specifically and individually, the students' attitudes toward various interactive simulations (similar to their favorite video games) and attitudes towards learning tasks that required work practice, thinking, and application of skills and content that were learned.

The results of the students that responded to open feedback which students were asked to comment on MIP (82%) showed that most of the students (89%) expressed very positive attitudes towards the various dimensions of MIP.

The results from the closed questions indicated that both the computerized applications (such as simulations) and the adjusted tasks contributed equally to students understanding, interest and enjoyment as shown in Figure 10.

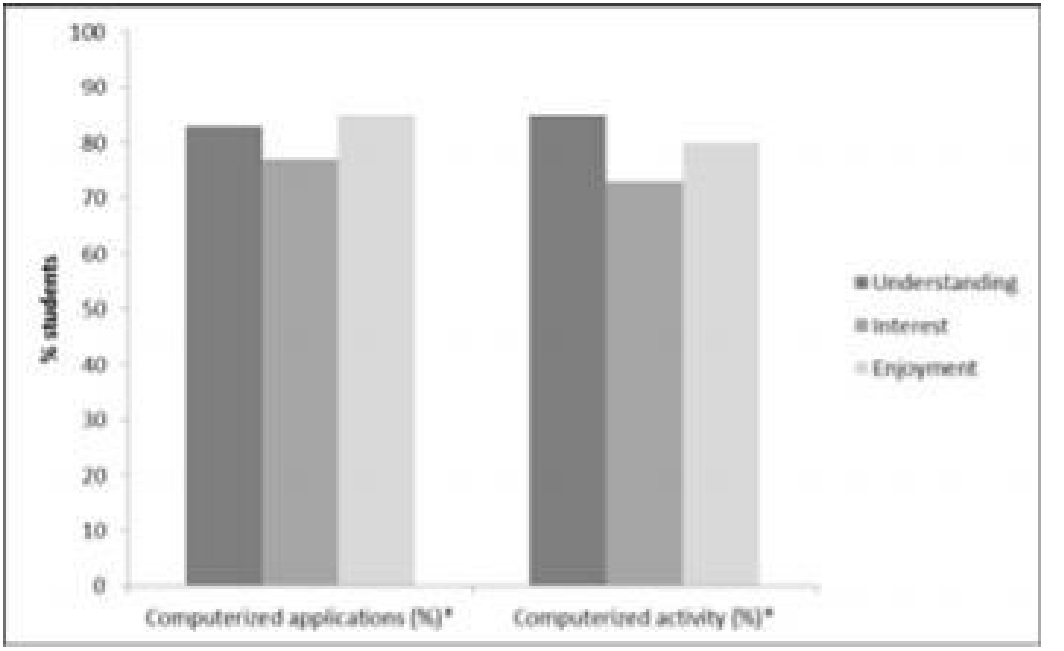


Figure 10: Students' responses regarding their levels of interest, understanding, and enjoyment of learning with MIP *shown combined percentage of levels 3 (much) and 4 (very much) in a 1-4 Likert-type questionnaire

Implementation of MIP

Last year we developed a second unit in MIP (based on the first unit template in Moodle platform) that combines the skills of scientific explanation and argument with the content in physics - relation between the height where the ball is first dropped and the height reached after the first bounce, the area under a speed–time graph and the experiment of Eratosthenes to calculate the Earth's radius as shown in Figure 11.

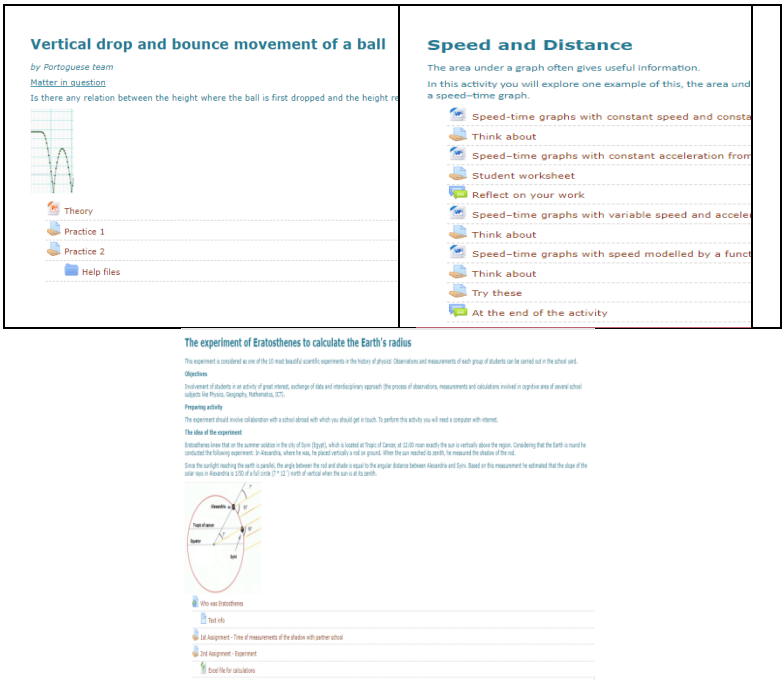


Figure 11: Second unit in MIP: explanation and argument skills incorporated within Physics content about "Relation between the height where the ball is first dropped and the height reached after the first bounce, the area under a speed–time graph and the experiment of Eratosthenes to calculate the Earth's radius"

Currently MIP units based on Moodle platform are embedded in 3 schools of DREAM project. Teachers reported that the MIP units enabled them to watch students' performance online and to intervene and support their learning processes accordingly. They also indicated that

their students were actively engaged in the visual computerized activities and showed a high level of interest. The level of students' understanding of the scientific contents was higher than before.

The MIP units enrich teacher's repertoires of pedagogical strategies, consequently leading to the design of new and improved pedagogies. Teachers indicated that they wanted to implement similar applications in the future.

MIP has a unique approach in combining teaching, training and implementing of learning skills with content in physics, math and technology. These reports have encouraged us to expand our design efforts covering a variety of contents and skills, where the computerized environment MIP stands as a framework for further developing for the following reasons:

- Teachers have need and desire for computerized environment such as MIP for teaching and learning because of the complication in developing due to lack of resources such as time and money.
- It is important to address the diversity of students, to challenge outstanding students and meanwhile provide good learning skills and knowledge to students with difficulties.
- Responding to existing needs in e-learning for short structured and targeted computerized environments that integrates contents and high-order thinking and learning skills.
- Lack of computerized environments that combine applets (as graphics, animation, audio, and video) with activities which enable a better understanding and learning of complex and abstract content.

We are continuing to develop additional units that combine various skills and content in physics, while addressing and

responding to student diversity. Additionally we conduct training for teachers on MIP units including pedagogy of teaching in a computerized environment. Some of the training courses are done in a completely E-learning environment that also was developed on the Moodle platform. The courses were successful and we intend to improve and continue them.

Summary and Conclusion

Math In Architecture (MIA), Math In Robotics (MIR) and Math in Physics (MIP) are all models of E-Learning environments developed on the Moodle platform, which is one of the major points of similarity. Other points of similarity are enabling a teaching–learning experience by promoting curiosity, interest, and understanding of the subject.

Development of MIA, MIR and MIP E-Learning environments on Moodle platform has led us to several important principles that need to be considered before developing additional environments:

- There is a huge need in E-learning environments based on curriculum content. The teachers do not have time to build them by themselves.
- It is important to base the environments according to teacher's needs, content based or technology based.
- The environments should address the student diversity
- There should be emphasis on design and simplicity of the environment enabling easy and enjoyable use that leads to understanding and development of interest in subjects that are considered hard to learn.

Comparing the essence of the two models – MIA and MIP,

we noticed the following differences:

1. Educational goals - MIA program is an extracurricular program. Its goals are developing math thinking skills, curiosity and interest in the field of architecture. The program is not integrated into our curricular school learning. This is its uniqueness and the source of its success. Success in the grades in school is not a goal of the program. MIP, on the other hand, is part of the curricular program as an enhancement to face-to-face teaching and the opportunity to supply both math and physics teachers with many interesting tools that can be used to improve the teaching–learning process and there is an importance for grades.
2. Different audiences – MIA focuses on 10^{th} grade school students where MIP focuses mainly on 11^{th}-12^{th} school students.
3. Size of the different community - The purpose of MIA is to create an international community of learning mathematics in architectural areas. MIP communities consist of a teacher and students in schools in Greece, Romany and Portugal who are learning certain curricular topics.

Overall, the perception of students of web-based homework testing was very positive. We plan to implement Moodle courses in additional subjects such as curricular chemistry and biology in order to improve and homogenize the basic knowledge of the students. We attend expanding the MIA by enabling communication between different schools in more countries and trying to develop math learning communities. We intend to guide math teachers using existing E-Learning environments and building independently new Moodle E-Learning math environments for the benefit of their classroom learning.

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