Moodle for Italian Astronomy Olympiad

G. Filippelli[(a)]

[(a)] *Osservatorio Astronomico di Brera*

Abstract

Italian Astronomy Olympiads are organized by Società Italiana di Astronomia in collaboration with Istituto Nazionale di Astrofisica (INAF) and they are included in the MIUR's upgrading program for educational excellence. The Presidency of the National Olympic Committee based at Osservatorio Astronomico di Brera (INAF).
Olympiads are aimed to italian high school students: the winners of the national stage participate to International Astronomy Olympiad (IAO). IAO officially born in 1996 at the initiative of Euro-Asian Astronomical Society. They are held every year in autumn, in a different country, and they see the regular participation of over twenty national teams of the European and Asian area, including Italy.
Today the didactical support is limited to the little material provided by Italian Committee on the italian official site. In order to supply this lack, we projected a didatcical platform, developed with Moodle, that it could propose astronomical learning pages like glossary's voices and a lot of exercises about every subject.

1 Introduction

CRESCERE[1] project was a collaboration between four different european institutions: Faculdade de ciencias de Universidade de Lisboa (FCUL), Laboratorio del Intrumentacao e Fisica Experimental de Particulas (LIP) from Portugal; Laboratori Nazionali di Frascati (LNF-INFN) from Italy; National Institute of Physics and Nuclear Energy "Horia Hulubei" (IFIN-HH) from Romania [11]. The four research institutions develop CRESCERE in order to introduce students of high school to modern physics and standard model.
In this way, theachers and students had the opportunity to use modern scientific apparatus to carry a real physics experiment with some web tools to sharing data and experiences. The aim of the experiment proposed is the measure of cosmic ray muons speed, flux or lifetime, according to experimental configuration [9].
In the first phase, there were two introductory seminars: the first about standard model of particle physics, basic concepts of special relativity and cosmic rays; the second to describe the experiment.
The on-line support is performed by the principle, italian site, Scienza per tutti, and a portuguese site with the instruction about installation and use of software needed to acquire data. Students sharing experiences and received supports trough chat, web-cam, e-mail. CRESCERE project used a combination

[1]Cosmic Rays in a Europe SChool Environment: a Remote Experiment

between presence[2] and web tools to support didactical and research activity of school students. Developing our project about Italian Astronomy Olympiad, we realize only one platform to collect all on-line support.
We choice to uso an on-line course managment systems, Moodle, for the following reasons:

1. the most widely offered system among institutions [4];
2. the possibility to use a lot of learning tools;
3. good integration with SCORM [7], the most used standard with learning object.

2 Moodle

Moodle is a course management system for online learning projected by Martin Dougiamas in order to realize the Peter C. Taylor's online course *Constructivism* [5, 6]. The acronym MOODLE stands for *Modular Object-Oriented Dynamic Learning Environment* [8].
In the following section, after a brief description of Moodle's theoretical background. we rapidly describe software's tools and the use of the courseware in physics.

2.1 Theoretical background

Theoretical background is constructivism[3], in particular *social constructivism* and *social constructionism*.

> These epistemological positions privilege a focus on collaborative discourse[4] and the individual development of meaning through construction and sharing of texts and other social artefacts[5]. From these perspectives, learners are apprenticed into "communities of practice" which embody certain beliefs and behaviours[6]. [6]

Following the thoery of *ways of knowing*[7] we can dinstinct between two different learning styles: *connected knowing* and *separate knowing*.

[2]For example, the project was concluded with a meeting in december 2005

[3]Jean Piaget, *Logique et Connaissance scientifique, Encyclopédie de la Pléiade* (1967)

[4]Amundsen, C., *The evolution of theory in distance education.* In D. Keegan (Ed.), Theoretical principles of distance education. London (1993): Routledge.
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Jonassen D. H., Peck K. L., Wilson B. G., *Learning with technology : a constructivist perspective.* Upper Saddle River, N.J.: Merrill (1999).

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> Connected knowers tend to learn cooperatively, and are more congenial and more willing to build on the ideas of others, while separate knowers tend to take a more critical and argumentative stance to learning. These styles are independent of intelligence or learning capacity, and independent of each other: each of us can may use both styles at different times[8]. [6]

2.2 Tools

We can embed in Moodle a lot of materials, organized in blocks, *each one allowing different kind of documentation to be shown* [16].
The documentation in every block is classified into two groups: resources and activities.
Resources are the contents a teacher brings into the course [16]. Every teacher can use following resources:
label; text and web pages link; directories; IMS content package.
Activities are things for students to do while they are logged on to the course [16]. There are a lot of standard activities:
Assignments: advanced uploading of files; on-line text; upload a single file; offline activity.
Chat; choice; database; forum; glossary; lesson; quiz; SCORM; survey; wiki.
Further activities can be enabling by course's administrator.

2.3 Moodle for Physics

According to Chonacky [10], computer was introduced in Physics education in 1970s. In 1980s Tim Berners-Lee and Robert Cailliau projected the World-Wide Web at CERN [1, 3] and they immediatly underline the importance of web in physics [2]: you can see that new computer technologies had a great importance in physics. So it's natural to introduce these technologies in physics education, and there's a lot of studies about the effectiveness of this use: for example Kenny et al. [15]. In this study researchers analize in particular problem based learning (PBL)

> PBL contrasts with more traditional subject based approaches where students are first taught a body of knowledge and then may have an opportunity to apply what they have learned to sample problems. With PBL, students work collaboratively in groups to identify what they need to learn in order to understand the problem and to learn about the broader concepts and principles related to the problem. PBL, therefore, is designed to encourage active participation by the students by immersing them in a situation. It requires them to define their own learning needs within broad goals set by faculty, then to identify and search for the knowledge that they need to obtain in order to solve the problem. [15]

[8] Galotti K. M., Clinchy B. M., Ainsworth K., Lavin B., Mansfield, A. F., *A New Way of Assessing Ways of Knowing: The Attitudes Towards Thinking and Learning Survey* (ATTLS). Sex Roles, 40(9/10), 745-766 (1999).

According to Barrows[9], Kelley and collegues proposed the following characteristics for PBL:

1. Problem-based. It begins with the presentation of a real life (authentic) problem stated as it might be encountered by practitioners.
2. Problem-solving. It supports the application of problem-solving skills required in "clinical practice." The role of the instructor is to facilitate the application and development of effective problem-solving processes.
3. Student-centred. Students assume responsibility for their own learning and faculty act as facilitators. Instructors must avoid making students dependent on them for what they should learn and know.
4. Self-directed learning. It develops research skills. Students need to learn how to get information when it is needed and will be current, as this is an essential skill for professional performance.
5. Reflection. This should take place following the completion of problem work, preferably through group discussion, and is meant to enhance transfer of learning to new problems.

The importance of problem solving was emphasized also by Landau [13]:

> researchers have found that incorporating technology within the problem-solving paradigm is a more effective way to teach science and technology than focusing directly on individual components[10].

Indeed:

> One cricial aspect of the process of learning Physics is to develop the ability to solve problems that represent different (more or less complex) physical situations. Students usually find it difficult to apply laws and equations they have seen in the classroom. [16]

Another important skills in physics is theory's application in realistic problem:

> We suggest that a better way to eliminate misconceptions might be to apply physics to realistic problems[11]. [13]

3 The platform for Astronomy Olympiad

> When a young people understands what we're saying, he involves himself, he becames passionate.

This words, by Marisa Michelini[12], have been one of inspirations in developing our project.
In the following section we shortly describe Italian Astronomy Olympiads, and our platform, with some screenshots about platform's home page, syllabus' pages, learning objects (with definition) and GeoGebra's applet uploaded.

[9]Barrows H. S., *The essentials of problem-based learning*, Journal of Dental Education, 62(9), 630-633 (1998)

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[11]Root-Bernstein R., *Discovering*, Random House, 1989

[12]Filippelli G., *Comunicare Fisica: giorno 3 - mattina*, 14th april 2010

3.1 Italian Astronomy Olympiad

Italian Astronomy Olympiads are organized by Società Italiana di Astronomia in collaboration with Istituto Nazionale di Astrofisica (INAF) and they are included in the MIUR's upgrading program for educational excellence. The Presidency of the National Olympic Committee based at Osservatorio Astronomico di Brera (INAF).
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3.2 Moodle's platform

> We run all our computation classes with a combination of lectures and "over the shoulder" labs. The students work on and discuss their projects with an instructor and then write them up as "executive summaries" with sections for the problem, equations, algorithms, code listings, visualizations, discussion, and critique. The emphasis is professional, much like reporting to a workplace manager. [13]

This quotation is the description of a good physics course: in our project we cannot use the labs option (eventually left to schools), but we can realizie a course structured like a web portal: in the introductory part we present the course, with links to every subject, and a lot of general on-line resources (see figure 1).

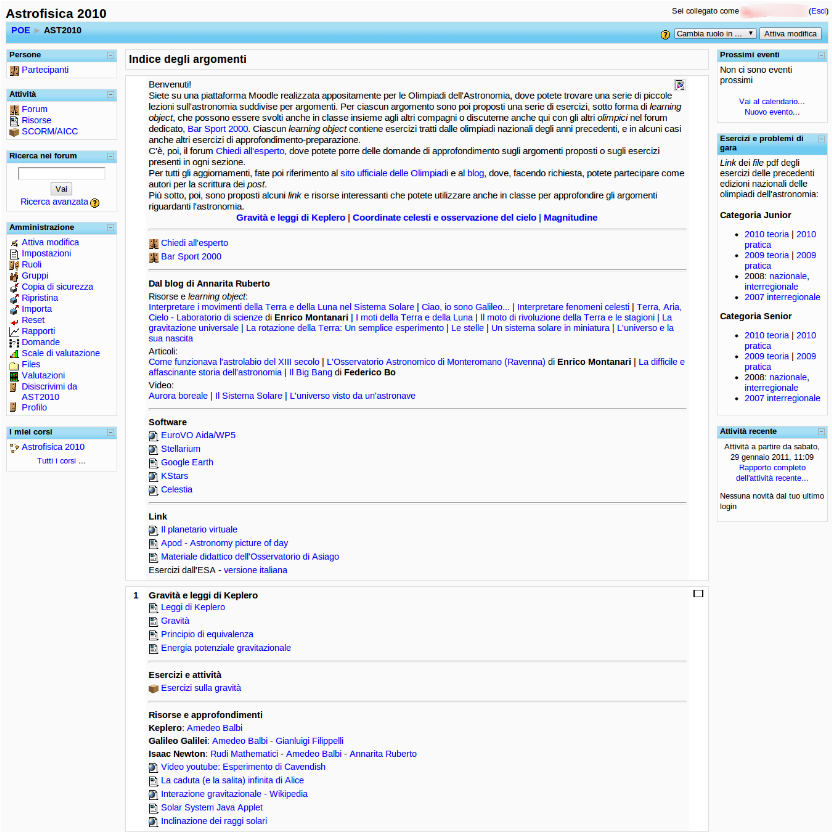


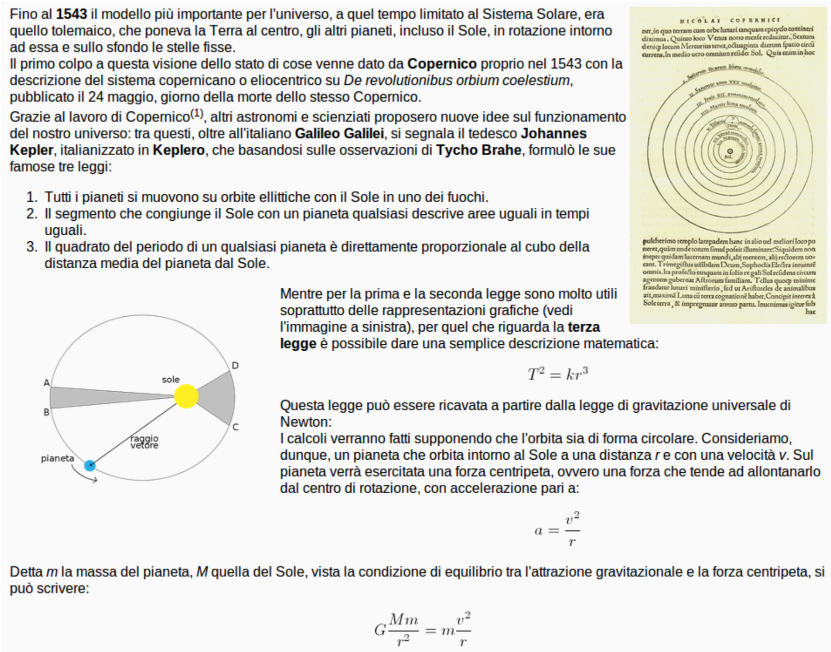
Figure 1: Screenshot of the course's home page

Course was setted in topic: for every topic we propose a lot af voices (for example *Kepler's laws*, see figure 2) like web pages, some external resources and some exercises like learning objects.
In order to encourage discussions and sharing about topics, we open two forums: *Ask to expert* for specific questions about astronomy and astrophysics; *Bar Sport 3000* for discussions between students.

3.3 Syllabus

For our prototipe, we choice the following three topic: *Gravity and Kepler's laws*[13], *Celestial coordinate system and sky's observation*[14], *Magnitude*[15]. Like in figure 2, we develop the key concepts of every topic like web pages with a brief historical introduction [12] and the mathematical develop of physical concepts.

[13] Gravità e leggi di Keplero
[14] Coordinate celesti e osservazione del cielo
[15] Magnitudine


Fino al **1543** il modello più importante per l'universo, a quel tempo limitato al Sistema Solare, era quello tolemaico, che poneva la Terra al centro, gli altri pianeti, incluso il Sole, in rotazione intorno ad essa e sullo sfondo le stelle fisse.
Il primo colpo a questa visione dello stato di cose venne dato da **Copernico** proprio nel 1543 con la descrizione del sistema copernicano o eliocentrico su *De revolutionibus orbium coelestium*, pubblicato il 24 maggio, giorno della morte dello stesso Copernico.
Grazie al lavoro di Copernico(1), altri astronomi e scienziati proposero nuove idee sul funzionamento del nostro universo: tra questi, oltre all'italiano **Galileo Galilei**, si segnala il tedesco **Johannes Kepler**, italianizzato in **Keplero**, che basandosi sulle osservazioni di **Tycho Brahe**, formulò le sue famose tre leggi:

1. Tutti i pianeti si muovono su orbite ellittiche con il Sole in uno dei fuochi.
2. Il segmento che congiunge il Sole con un pianeta qualsiasi descrive aree uguali in tempi uguali.
3. Il quadrato del periodo di un qualsiasi pianeta è direttamente proporzionale al cubo della distanza media del pianeta dal Sole.

Mentre per la prima e la seconda legge sono molto utili soprattutto delle rappresentazioni grafiche (vedi l'immagine a sinistra), per quel che riguarda la **terza legge** è possibile dare una semplice descrizione matematica:

$$T^2 = kr^3$$

Questa legge può essere ricavata a partire dalla legge di gravitazione universale di Newton:
I calcoli verranno fatti supponendo che l'orbita sia di forma circolare. Consideriamo, dunque, un pianeta che orbita intorno al Sole a una distanza *r* e con una velocità *v*. Sul pianeta verrà esercitata una forza centripeta, ovvero una forza che tende ad allontanarlo dal centro di rotazione, con accelerazione pari a:

$$a = \frac{v^2}{r}$$

Detta *m* la massa del pianeta, *M* quella del Sole, vista la condizione di equilibrio tra l'attrazione gravitazionale e la forza centripeta, si può scrivere:

$$G\frac{Mm}{r^2} = m\frac{v^2}{r}$$

Figure 2: Extract for *Kepler's laws* page

3.4 Learning Objects and exercises

The better definition for *learning object* (LO) is the following:

> Learning object is a digital or otherwise, which pursuing a specific educational objective, which is used by both teachers, both students independently and without a predefined sequence. [14]

Another useful definition is provided by Peter Dourmashkin at Comunicare Fisica[16]:

- Create an engaging and technologically enabled active learning environment
- Move away from passive lecture/recitation format
- Incorporate hands-on experiments
- Enhance conceptual understanding
- Enhance problem-solving ability

In order to promote, in particolar, problem-solving ability we develop our LO exclusively with exercises: produced using the rapid e-learning software eXeLearning, every exercise was divided into two parts, the text and the calculations; the student can see the second part simply clicking a button in the bottom of the first part.

[16] Filippelli G., *Peter Dourmashkin: the learning according to the MIT*, 20th april 2010

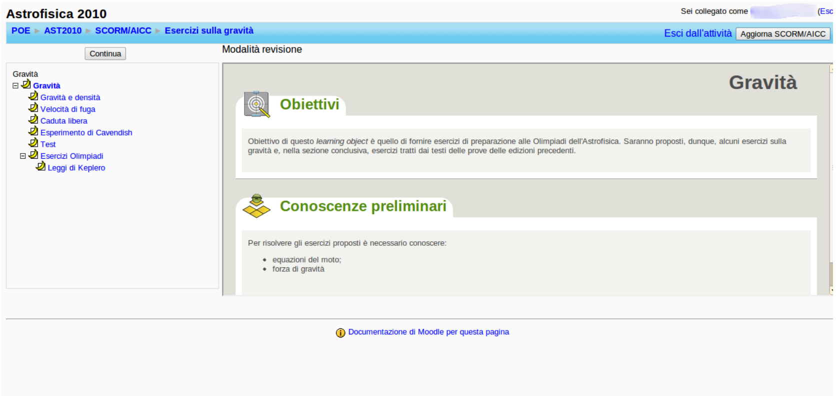


Figure 3: Screenshot of Gravity's SCORM

Figure 4: Screenshot of Gravity's SCORM

3.4.1 GeoGebra's applet

Another interesting idea was expressed by Maria Peressi:

> Today physics learning paradigms are summarized with the following three words: experiments, theories, simulations[17].

In order to follow this idea we start to embed in our platform one simulation realized with GeoGebra, an open software used in high school in order to teach and apply geometry theorems.
GeoGebra is:

> (...) a free software that brings mathematics geometry, algebra and calculus (...)

[17] Maria Peressi, see Filippelli G. *Comunicare Fisica: giorno 2 - pomeriggio*, 13rd april 2010
Maria Peressi proposed a project in which students, whit a little math skills (Pitagora's theorem and measurement tasks) realized an algorithm to calculate the refractive index. See the internet site of the project: Fare Scienza con il computer (01/27/2010)

It was built in Java and its applets are available on the internet and can run on Windows, Linux and Macintosh [19]

In order to show gnomone's use, we choice the geometrical skills: using a slider, students can change the position of the sun, so inclination of the ray of light changes, and also the lenght of the stick's shadow (see figure 5).

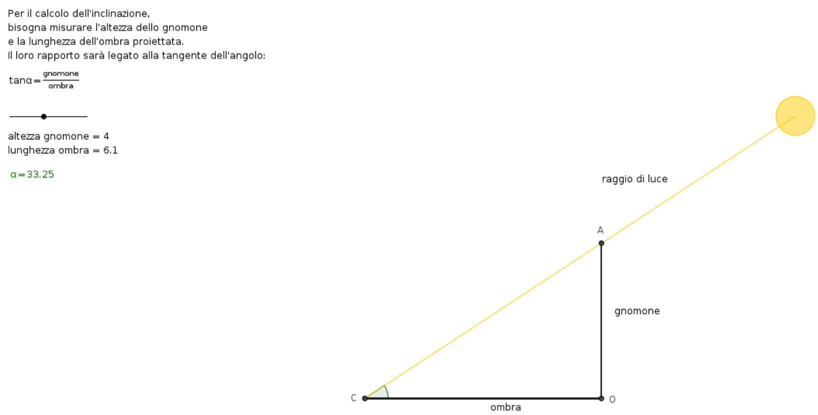


Figure 5: Screenshot of GeoGebra's applet

4 Future developing

First of all, we'll write new voices following the example of the online syllabus of the IOAA. For learning object we'll produce new exercises about every syllabus' voice, and we'll finally embed some animation and simulation about astronomy and astrophysics from institutional sites (ESA, NASA, Astronomycal Observators).

Probably we'll improve the integration with official site, periodically proposing some contribution extract from Moodle's platform: for example *The month's exercise*, a post with text and resolution of one exercise of our platform.

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