INTERACTIVE COMPUTER MODELS FOR EDUCATION AND DISTANCE LEARNNING AT INTERNET PORTAL MOKSLASPLIUS.LT (SCIENCEPLUS)

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Abstract

We overview our experience in the development of science popularisation portal mokslasplius.lt (SciencePlus.lt) presenting interactive computer models and their application in education (including self-education) and distance learning of natural sciences.

In particular, software package AnyLogic used for the development of computer models is described, also possibilities of its usage for the creation of platform-independent computer models that do not require any proprietary software on the user's side, are emphasised.

In the article we provide examples of several interactive computer models, as planetary system, motion of space bodies according to Kepler's law, movement of mathematical pendulum and changes of its energy states. These and other models, developed with AnyLogic, being stand-alone learning objects, that can be opened in computer that has only internet connection and web browser, can be easily integrated into lecture or laboratory work and can serve as a visually appealing illustration of phenomenon in question, tool for students motivation and object for analysis and discussion.

We pay particular attention to possibilities of usage of such computer models, that illustrate various real-world physical phenomenon, in educational process, in computer classes or at home, especially in conjunction with other educational information that is prepared and published in portal mokslasplius.lt, as main formulas of physics and mathematics, science news, videos of amazing experiments, multimedia courses and other data of this science popularisation portal.

Keywords

Distance education, E-learning, Interactive learning, Learning object, Computer Modelling and Simulation, Educational Web Environment

Science popularisation portal MokslasPlius.lt

Internet portal mokslasplius.lt (SciencePlus) is being developed by four Lithuanian scientific organisations – Institute of Physics and Astronomy, Institute of Mathematics and Informatics, Planetarium of Institute of Theoretical Physics, and Lithuanian Scientific Society. The aim of this project is to build modern means for the dissemination of scientific and educational knowledge among society and to present this information in appealing and attractive ways, especially targeting school pupil of higher grades and students, while utilising modern internet technologies. Computer models are becoming important additional tool for education, teaching and distance learning, as they allow better understand science laws, relate behaviour of models with theoretical formulas and own experience, while visualisation and animation of the processes, together with interactive user interface, create an appealing environment that encourage web site visitor to experiment with models, ask questions or give comments, motivate for further studying the subject (Perkins, Adams, 2004). This project, called "Science. Scientists. Society." is partly funded by the European Social Fund.

The creation of interactive computer models has branched into an important activity of the whole project, as it turned out to be efficient way to present phenomena of physics, giving

models as a kind of "toy" to portal visitors to play with, but at the same time making one to think about behaviour of the model and to relate it with underlying formulas and theoretical knowledge. Computer models interest visitors and motivate them for the further learning.

Computer model development software AnyLogic

One of software tools chosen for development of such interactive computer models was software package *AnyLogic*, developed by the company XJ Technologies, Russia (XJ Technologies, 2008).

It is general-purpose simulation tool with many modelling opportunities that include possibilities of capturing a great variety of real-world phenomena of discrete, continuous and hybrid nature. Application areas of *AnyLogic* are quite diverse, including education, science, mechanics, industry (logistics, production cycle simulation, market analysis, etc.), telecommunications, computer networks and many others.

The main advantages why we have chosen this software as one of the development tools is the possibility to export models to pure Java applets which then can be published on the internet, built-in graphics, included in the libraries of algebraic functions, numerical solvers of differential equations, unified modelling language type state charts, integrated into graphical and animation editors and other useful features (Figure 1.).

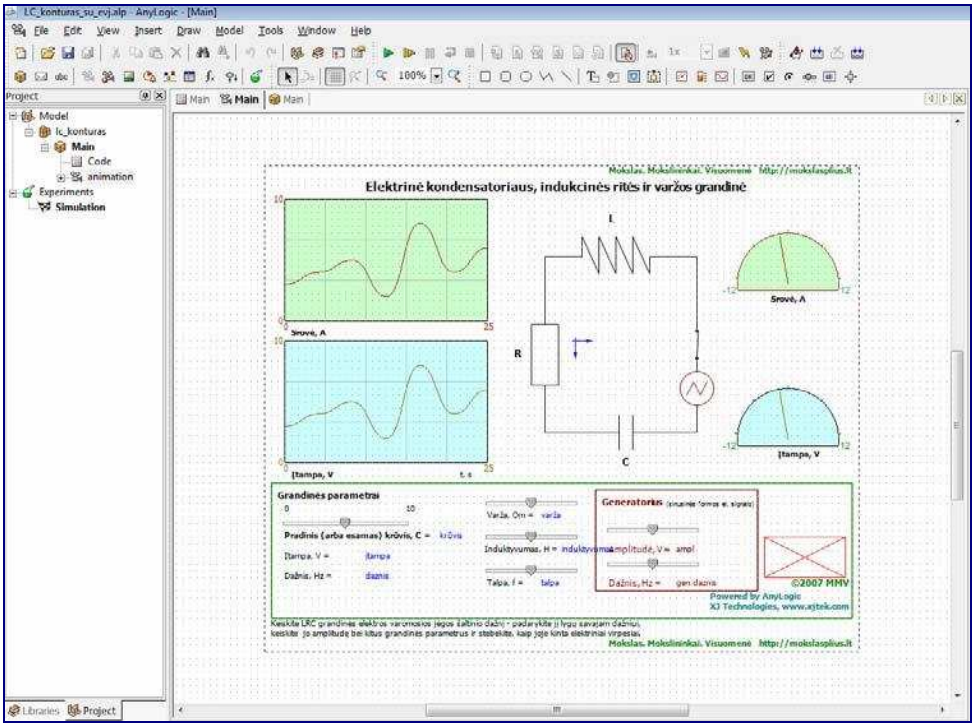

Figure 1. Graphical user interface of *AnyLogic*.

Teaching and learning with computer models

With AnyLogic we have developed around 10 computer models in the portal SciencePlus, however, there are more than 50 interactive computer simulations, others being built using other software packages, as *WebMatematica*, *NetLogo* and *Java* (Daniūnas, Gontis, Acus, 2007).

Models with *AnyLogic* were developed having in mind interactivity and visual appealing. We tried to choose not very complex phenomena, thus making models usable as stand-alone learning objects as well. Developed models also can be used just as an illustration of the physics or astronomy course, during lectures or laboratory works.

Every model contains either short theory, sometimes with formulas, or just description how it can be used and what physical law or phenomenon it illustrates. For the users convenience we have quite extensive reference book of main formulas of physics, mathematics and astronomy in this portal, so interested users can follow links provided at the end of each model description and find formulas and more detailed information. Sometimes links lead to the external sources, mostly in English language.
All models, reference book and other information in portal *mokslasplius.lt* are in Lithuanian language, as there is a lack of high-quality science popularisation and learning content on the Internet in Lithuanian language.
For instance, this model, built with *AnyLogic* illustrates planetary system with three satellites.

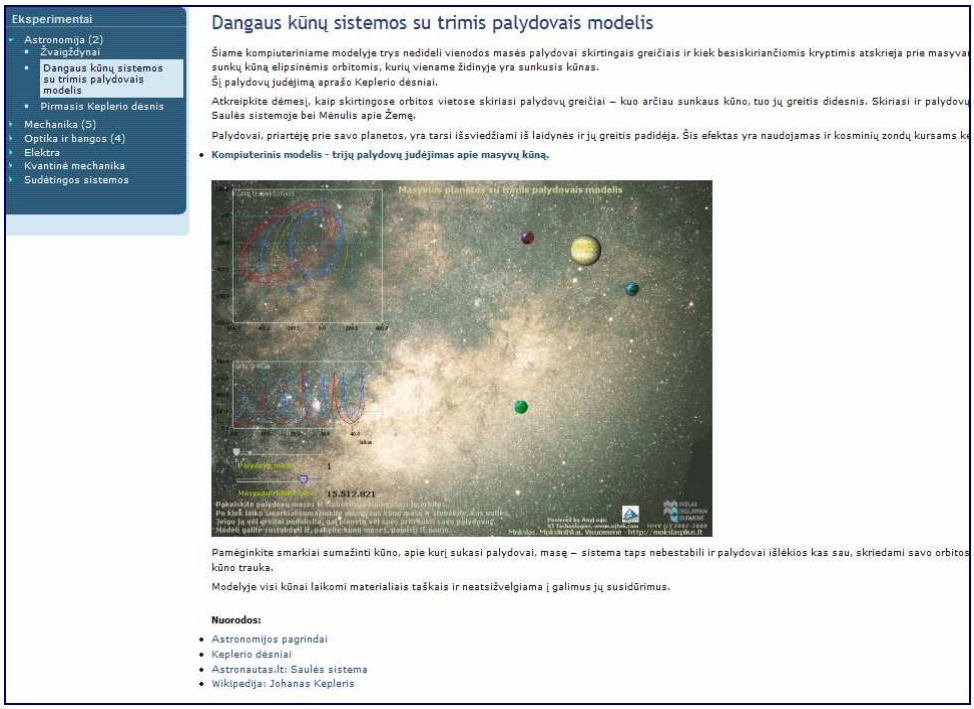

Figure 2. Web page with description of computer model.

Visitor can simply click on a picture and open computer model itself (Figure 3.), where one can watch movement of the satellites in gravitational field of massive planet, also change masses of all bodies and see how orbits of satellites are changing. Chart on the upper-left corner plots orbits of satellites moving in the model window and chart on the lower-left corner plots the change of speeds over time. Links below the model description lead to the topics of Astronomy basics, Kepler laws (both located at the same portal), Solar system (website of astronomy enthusiasts) and Johannes Kepler web site on Wikipedia.

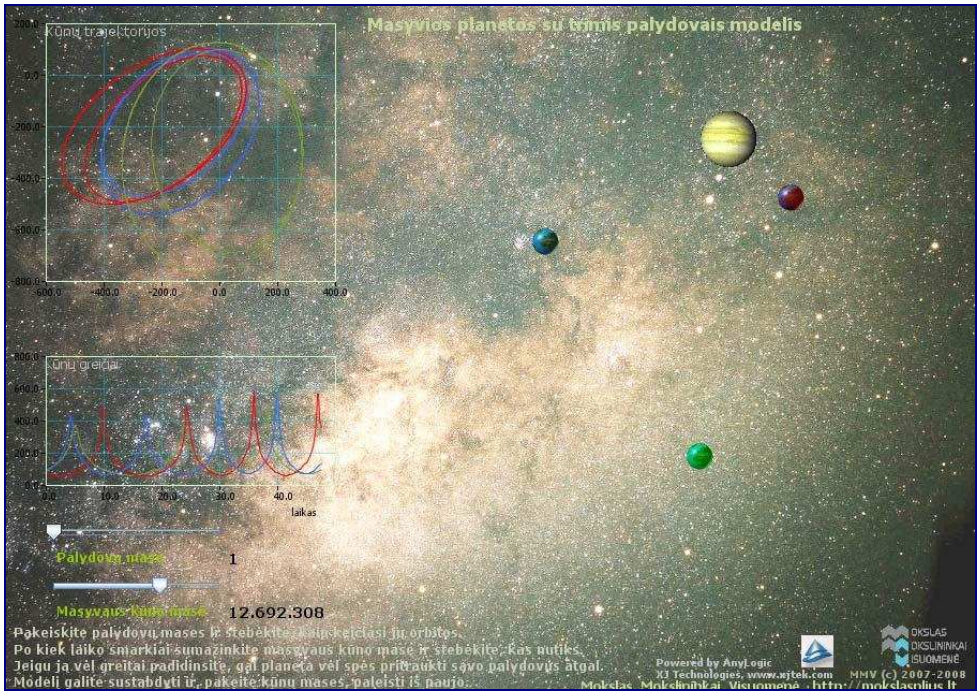

Figure 3. Model of planetary system with three satellites.

Another astronomy computer model illustrates Kepler law: initial velocities and masses of satellites are chosen in a way that one satellite is caught by gravitational field of massive planet and enters circle orbit, another one - elliptical, third - hyperbolic, and spaceship - parabolic. All these orbits are drawn on the chart too. Students can restart model with changed mass of the planet and see resulting changes in orbits of satellites - like how hyperbolic trace bends in a higher extend due to stronger gravitational field, or spaceship is being caught by the planet and start circling in elliptical orbit instead of parabolic.

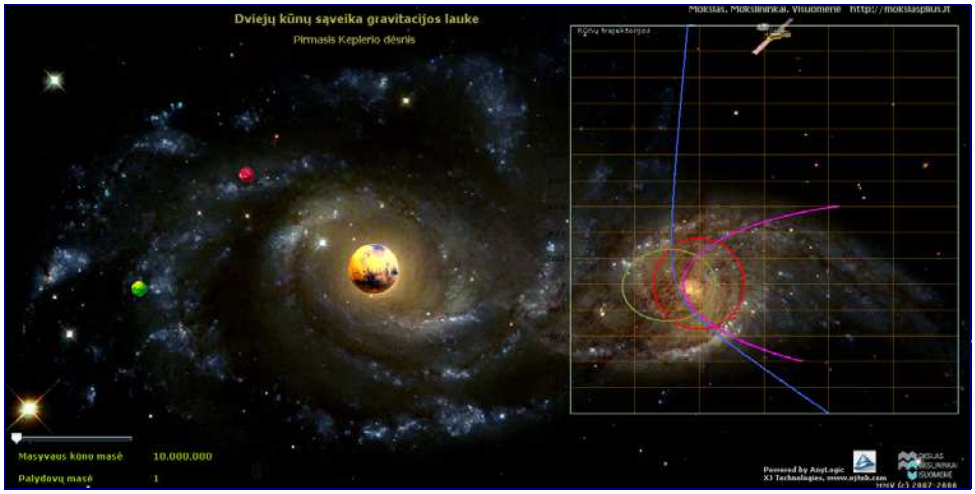

Figure 4. Model that illustrates Kepler law of planetary motion.

Other models developed with *AnyLogic* include mathematical pendulum (Figure 5.), double pendulum, electrical circuit with capacitor, resistor and inductive coil, also more complex systems, as two body system with changing of mass, multi-agent Shelling segregation model, deterministic non-periodic flow of E.N Lorentz, and others.

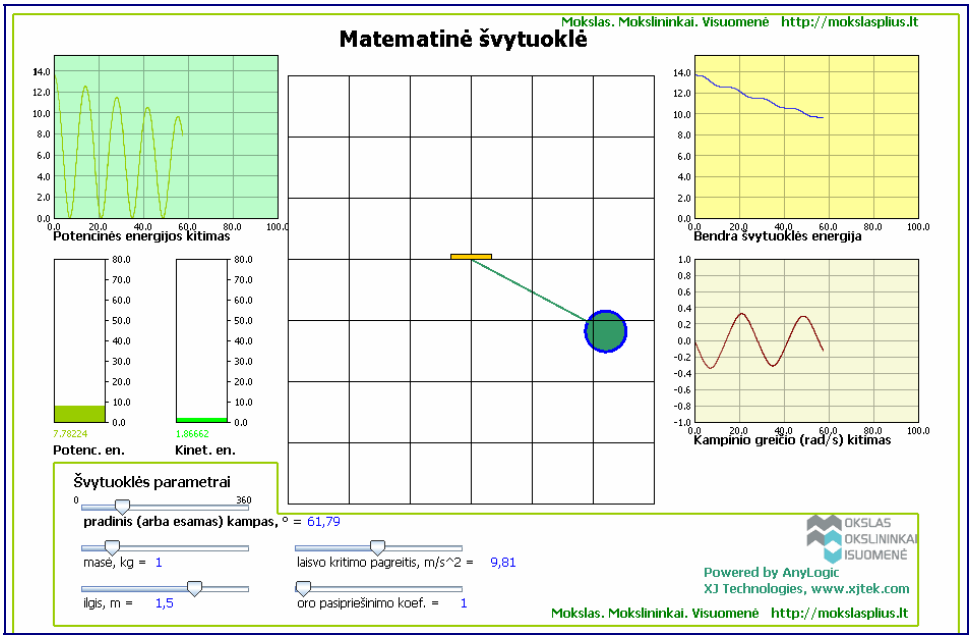

Figure 5. Model of mathematical pendulum.

Wide accessibility of computer models

All educational computer models built with *AnyLogic* as Java applets and published on the web portal *mokslasplius.lt* are platform-independent, so they can be run on any computer that has internet browser, as Mozilla Firefox, Internet Explorer, Opera. Free Java virtual machine plug-in is necessary - if it is not installed, browser suggests to download it when user tries to run computer model in the internet browser window for the first time.

Thus computer models do not require any other software except internet browser and can be used on any distant computer, should it be a computer in physics class or home computer of the student who wants to deepen his or her knowledge. Portal does not require registration and is open to all visitors.

Conclusions

Computer simulation on the web portal *mokslasplius.lt* facilitates better understanding of science laws, visualizes behaviour of presented models, motivates students, serves as a general natural sciences promotion tool, and allows even to have some fun during teaching and learning process.

These models could be particularly useful for distance teaching and learning, as they can be used without any computer knowledge - models start just with a mouse click, while graphical user interface is very simple. The teacher is free of preparation work, for instance, if he wants to show models to the class - simulations are ready to use and work directly in a browser window.

As internet coverage is increasing very fast (40% of Lithuanian families already have computer with internet connection, while this number in 2000 was only 2%, and 80% educational institutions computers are connected to the internet), these computer models and simulations could be widely used in distance learning. The valuable information, as physics, mathematics and astronomy reference book, downloadable materials of multimedia courses, models of physics of risk, science news and other interesting educational and science popularisation data, contained on the portal *mokslasplius.lt,* facilitate distance learning opportunities as well.

References

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